IP SLAs Configuration Guide, Cisco IOS XE Release 3SE (Catalyst 3850 Switches)

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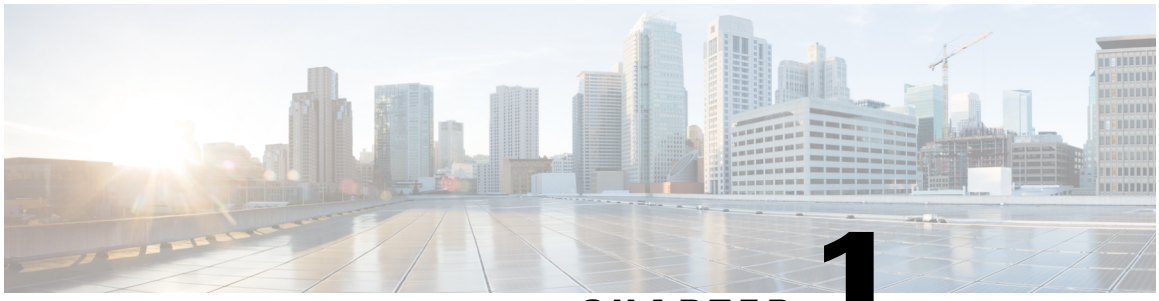

CHAPTER 1

IP SLAs Overview

This module describes IP Service Level Agreements (SLAs). IP SLAs allows Cisco customers to analyze IP service levels for IP applications and services, to increase productivity, to lower operational costs, and to reduce the frequency of network outages. IP SLAs uses active traffic monitoring--the generation of traffic in a continuous, reliable, and predictable manner--for measuring network performance. Using IP SLAs, service provider customers can measure and provide service level agreements, and enterprise customers can verify service levels, verify outsourced service level agreements, and understand network performance. IP SLAs can perform network assessments, verify quality of service (QoS), ease the deployment of new services, and assist administrators with network troubleshooting. IP SLAs can be accessed using the Cisco software commands or Simple Network Management Protocol (SNMP) through the Cisco Round-Trip Time Monitor (RTTMON) and syslog Management Information Bases (MIBs).

Finding Feature Information

Your software release may not support all the features documented in this module. For the latest caveats and feature information, see Bug Search Tool and the release notes for your platform and software release. To find information about the features documented in this module, and to see a list of the releases in which each feature is supported, see the feature information table.

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Information About IP SLAs

IP SLAs Technology Overview

Cisco IP SLAs uses active traffic monitoring--the generation of traffic in a continuous, reliable, and predictable manner--for measuring network performance. IP SLAs sends data across the network to measure performance

between multiple network locations or across multiple network paths. It simulates network data and IP services, and collects network performance information in real time. The information collected includes data about response time, one-way latency, jitter (interpacket delay variance), packet loss, voice quality scoring, network resource availability, application performance, and server response time. IP SLAs performs active monitoring by generating and analyzing traffic to measure performance either between Cisco devices or from a Cisco device to a remote IP device such as a network application server. Measurement statistics provided by the various IP SLAs operations can be used for troubleshooting, for problem analysis, and for designing network topologies.

Using IP SLAs, service provider customers can measure and provide service level agreements, and enterprise customers can verify service levels, verify outsourced service level agreements, and understand network performance for new or existing IP services and applications. IP SLAs uses unique service level assurance metrics and methodology to provide highly accurate, precise service level assurance measurements.

Depending on the specific IP SLAs operation, statistics of delay, packet loss, jitter, packet sequence, connectivity, path, server response time, and download time can be monitored within the Cisco device and stored in both CLI and SNMP MIBs. The packets have configurable IP and application layer options such as a source and destination IP address, User Datagram Protocol (UDP)/TCP port numbers, a type of service (ToS) byte (including Differentiated Services Code Point [DSCP] and IP Prefix bits), a Virtual Private Network (VPN) routing/forwarding instance (VRF), and a URL web address.

Being Layer-2 transport independent, IP SLAs can be configured end-to-end over disparate networks to best reflect the metrics that an end-user is likely to experience. Performance metrics collected by IP SLAs operations include the following:

- Delay (both round-trip and one-way)
- Jitter (directional)
- Packet loss (directional)
- Packet sequencing (packet ordering)
- Path (per hop)
- Connectivity (directional)
- Server or website download time
- Voice quality scores

Because IP SLAs is accessible using SNMP, it also can be used by performance monitoring applications like CiscoWorks Internetwork Performance Monitor (IPM) and other third-party Cisco partner performance management products. For details about network management products that use IP SLAs, see http://www.cisco.com/go/ipsla .

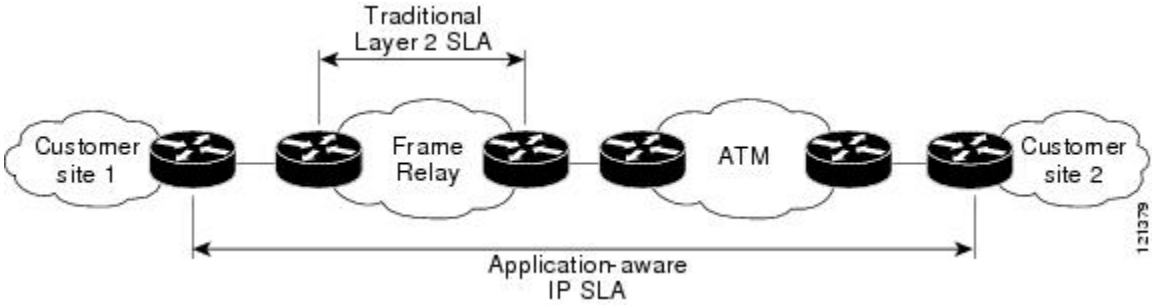
SNMP notifications based on the data gathered by an IP SLAs operation allow the router to receive alerts when performance drops below a specified level and when problems are corrected. IP SLAs uses the Cisco RTTMON MIB for interaction between external Network Management System (NMS) applications and the IP SLAs operations running on the Cisco devices. For a complete description of the object variables referenced by the IP SLAs feature, refer to the text of the CISCO-RTTMON-MIB.my file, available from the Cisco MIB website .

Service Level Agreements

Internet commerce has grown significantly in the past few years as the technology has advanced to provide faster, more reliable access to the Internet. Many companies now need online access and conduct most of their business online and any loss of service can affect the profitability of the company. Internet service providers (ISPs) and even internal IT departments now offer a defined level of service--a service level agreement--to provide their customers with a degree of predictability.

The latest performance requirements for business-critical applications, voice over IP (VoIP) networks, audio and visual conferencing, and VPNs are creating internal pressures on converged IP networks to become optimized for performance levels. Network administrators are increasingly required to support service level agreements that support application solutions. The figure below shows how IP SLAs has taken the traditional concept of Layer 2 service level agreements and applied a broader scope to support end-to-end performance measurement, including support of applications.

Figure 1: Scope of Traditional Service Level Agreement Versus IP SLAs



IP SLAs provides the following improvements over a traditional service level agreement:

- End-to-end measurements--The ability to measure performance from one end of the network to the other allows a broader reach and more accurate representation of the end-user experience.
- Sophistication--Statistics such as delay, jitter, packet sequence, Layer 3 connectivity, and path and download time that are broken down into bidirectional and round-trip numbers provide more data than just the bandwidth of a Layer 2 link.
- Ease of deployment--Leveraging the existing Cisco devices in a large network makes IP SLAs easier and cheaper to implement than the physical probes often required with traditional service level agreements.
- Application-aware monitoring--IP SLAs can simulate and measure performance statistics generated by applications running over Layer 3 through Layer 7. Traditional service level agreements can only measure Layer 2 performance.
- Pervasiveness--IP SLAs support exists in Cisco networking devices ranging from low-end to high-end devices and switches. This wide range of deployment gives IP SLAs more flexibility over traditional service level agreements.

When you know the performance expectations for different levels of traffic from the core of your network to the edge of your network, you can confidently build an end-to-end application-aware service level agreement.

Benefits of IP SLAs

- IP SLAs monitoring
  - Provides service level agreement monitoring, measurement, and verification.
- Network performance monitoring
  - Measures the jitter, latency, or packet loss in the network.
  - Provides continuous, reliable, and predictable measurements.
- IP service network health assessment
  - Verifies that the existing QoS is sufficient for new IP services.
- Edge-to-edge network availability monitoring
  - Provides proactive verification and connectivity testing of network resources (for example, indicates the network availability of a Network File System (NFS) server used to store business critical data from a remote site).
- Troubleshooting of network operation
  - Provides consistent, reliable measurement that immediately identifies problems and saves troubleshooting time.
- Voice over IP (VoIP) performance monitoring
- Multiprotocol Label Switching (MPLS) Virtual Private Network (VPN) performance monitoring and network verification

Network Performance Measurement Using IP SLAs

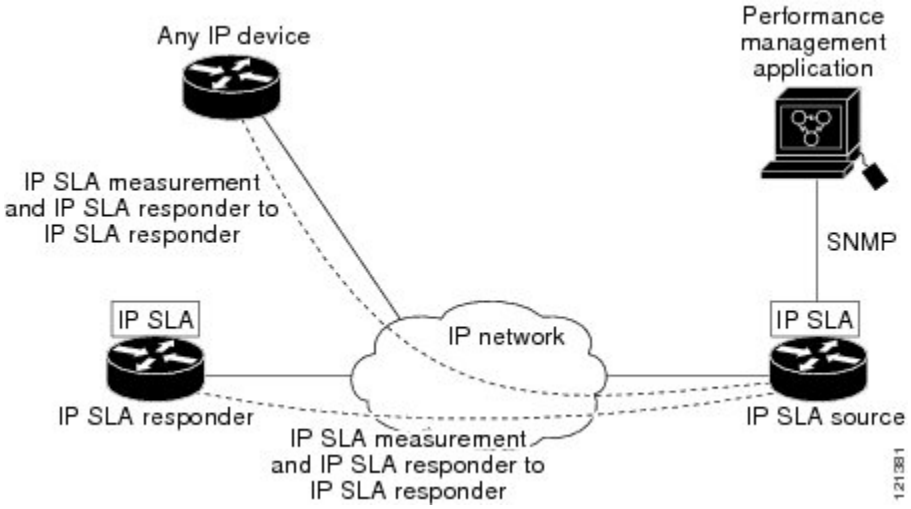
Using IP SLAs, a network engineer can monitor the performance between any area in the network: core, distribution, and edge. Monitoring can be done anytime, anywhere, without deploying a physical probe.

The IP SLAs Probe Enhancements feature is an application-aware synthetic operation agent that monitors network performance by measuring response time, network resource availability, application performance, jitter (interpacket delay variance), connect time, throughput, and packet loss. Performance can be measured between any Cisco device that supports this feature and any remote IP host (server), Cisco routing device, or mainframe host. Performance measurement statistics provided by this feature can be used for troubleshooting, for problem analysis, and for designing network topologies.

IP SLAs uses generated traffic to measure network performance between two networking devices. The figure below shows how IP SLAs starts when the IP SLAs device sends a generated packet to the destination device. After the destination device receives the packet, and depending on the type of IP SLAs operation, the device will respond with time-stamp information for the source to make the calculation on performance metrics. An

IP SLAs operation performs a network measurement from the source device to a destination in the network using a specific protocol such as UDP.

Figure 2: IP SLAs Operations



To implement IP SLAs network performance measurement you need to perform these tasks:

1. Enable the IP SLAs Responder, if appropriate.
2. Configure the required IP SLAs operation type.
3. Configure any options available for the specified IP SLAs operation type.
4. Configure threshold conditions, if required.
5. Schedule the operation to run, then let the operation run for a period of time to gather statistics.
6. Display and interpret the results of the operation using Cisco software commands or an NMS system with SNMP.

IP SLAs Responder and IP SLAs Control Protocol

The IP SLAs Responder is a component embedded in the destination Cisco routing device that allows the system to anticipate and respond to IP SLAs request packets. The IP SLAs Responder provides an enormous advantage with accurate measurements without the need for dedicated probes and additional statistics not available via standard ICMP-based measurements. The patented IP SLAs Control Protocol is used by the IP SLAs Responder providing a mechanism through which the responder can be notified on which port it should listen and respond. Only a Cisco device can be a source for a destination IP SLAs Responder.

The figure "IP SLAs Operations" in the "Network Performance Measurement Using IP SLAs" section shows where the IP SLAs Responder fits in relation to the IP network. The IP SLAs Responder listens on a specific port for control protocol messages sent by an IP SLAs operation. Upon receipt of the control message, the responder will enable the specified UDP or TCP port for the specified duration. During this time, the responder accepts the requests and responds to them. The responder disables the port after it responds to the IP SLAs packet, or when the specified time expires. For added security, MD5 authentication for control messages is available.

Enabling the IP SLAs Responder on the destination device is not required for all IP SLAs operations. For example, if services that are already provided by the destination device (such as Telnet or HTTP) are chosen, the IP SLAs Responder need not be enabled. For non-Cisco devices, the IP SLAs Responder cannot be configured and IP SLAs can send operational packets only to services native to those devices.

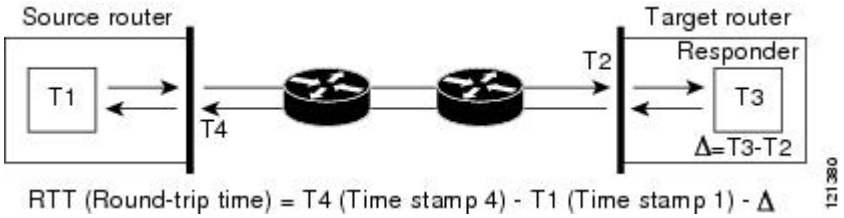
Response Time Computation for IP SLAs

Devices may take tens of milliseconds to process incoming packets, due to other high-priority processes. This delay affects the response times because the reply to test packets might be sitting on queue while waiting to be processed. In this situation, the response times would not accurately represent true network delays. IP SLAs minimizes these processing delays on the source device as well as on the target device (if IP SLAs Responder is being used), in order to determine true round-trip times. IP SLAs test packets use time stamping to minimize the processing delays.

When enabled, the IP SLAs Responder allows the target device to take two time stamps both when the packet arrives on the interface at interrupt level and again just as it is leaving, eliminating the processing time. At times of high network activity, an ICMP ping test often shows a long and inaccurate response time, while an IP SLAs test shows an accurate response time due to the time stamping on the responder.

The figure below demonstrates how the responder works. Four time stamps are taken to make the calculation for round-trip time. At the target device, with the responder functionality enabled time stamp 2 (TS2) is subtracted from time stamp 3 (TS3) to produce the time spent processing the test packet as represented by delta. This delta value is then subtracted from the overall round-trip time. Notice that the same principle is applied by IP SLAs on the source device where the incoming time stamp 4 (TS4) is also taken at the interrupt level to allow for greater accuracy.

Figure 3: IP SLAs Responder Time Stamping



An additional benefit of the two time stamps at the target device is the ability to track one-way delay, jitter, and directional packet loss. Because much network behavior is asynchronous, it is critical to have these statistics. However, to capture one-way delay measurements the configuration of both the source device and target device with Network Time Protocol (NTP) is required. Both the source and target need to be synchronized to the same clock source. One-way jitter measurements do not require clock synchronization.

IP SLAs Operation Scheduling

After an IP SLAs operation has been configured, you must schedule the operation to begin capturing statistics and collecting error information. When scheduling an operation, it can start immediately or start at a certain month, day, and hour. There is a pending option to set the operation to start at a later time. The pending option is also an internal state of the operation visible through SNMP. The pending state is also used when an operation is a reaction (threshold) operation waiting to be triggered. You can schedule a single IP SLAs operation or a group of operations at one time.

Multioperations scheduling allows you to schedule multiple IP SLAs operations using a single Cisco software command or the CISCO RTTMON-MIB. This feature allows you to control the amount of IP SLAs monitoring traffic by scheduling the operations to run at evenly distributed times. This distribution of IP SLAs operations helps minimize the CPU utilization and thereby enhances the scalability of the network.

For more details about the IP SLAs multioperations scheduling functionality, see the "IP SLAs-Multioperation Scheduling of IP SLAs Operations" module of the *IP SLAs Configuration Guide* .

IP SLAs Operation Threshold Monitoring

To support successful service level agreement monitoring or to proactively measure network performance, threshold functionality becomes essential. Consistent reliable measurements immediately identify issues and can save troubleshooting time. To confidently roll out a service level agreement you need to have mechanisms that notify you immediately of any possible violation. IP SLAs can send SNMP traps that are triggered by events such as the following:

- Connection loss
- Timeout
- Round-trip time threshold
- Average jitter threshold
- One-way packet loss
- One-way jitter
- One-way mean opinion score (MOS)
- One-way latency

Alternately, an IP SLAs threshold violation can trigger another IP SLAs operation for further analysis. For example, the frequency could be increased or an ICMP path echo or ICMP path jitter operation could be initiated for troubleshooting.

Determining the type of threshold and the level to set can be complex, and it depends on the type of IP service being used in the network. For more details on using thresholds with IP SLAs operations, see the "IP SLAs-Proactive Threshold Monitoring of IP SLAs Operations" module of the *IP SLAs Configuration Guide* .

MPLS VPN Awareness

The IP SLAs MPLS VPN Awareness feature provides the capability to monitor IP service levels within Multiprotocol Label Switching (MPLS) Virtual Private Networks (VPNs). Using IP SLAs within MPLS VPNs allows service providers to plan, provision, and manage IP VPN services according to the service level agreement for a customer. IP SLAs operations can be configured for a specific VPN by specifying a VPN routing and forwarding (VRF) name.

History Statistics

IP SLAs maintains the following three types of history statistics:

- Aggregated statistics--By default, IP SLAs maintains two hours of aggregated statistics for each operation. Value from each operation cycle is aggregated with the previously available data within a given hour. The Enhanced History feature in IP SLAs allows for the aggregation interval to be shorter than an hour.
- Operation snapshot history--IP SLAs maintains a snapshot of data for each operation instance that matches a configurable filter, such as all, over threshold, or failures. The entire set of data is available and no aggregation takes place.
- Distribution statistics--IP SLAs maintains a frequency distribution over configurable intervals. Each time IP SLAs starts an operation, a new history bucket is created until the number of history buckets matches the specified size or the lifetime of the operation expires. By default, the history for an IP SLAs operation is not collected. If history is collected, each bucket contains one or more history entries from the operation. History buckets do not wrap.

Additional References

Related Documents

Related Topic	Document Title
Cisco IOS commands	Cisco IOS Master Commands List, All Releases
IP SLAs commands	*IP SLAs Command Reference*

Standards

Standards	Title
ITU-T G.711 u-law and G.711 a-law	Pulse code modulation (PCM) of voice frequencies
ITU-T G.729A	Reduced complexity 8 kbit/s CS-ACELP speech codec

MIBs

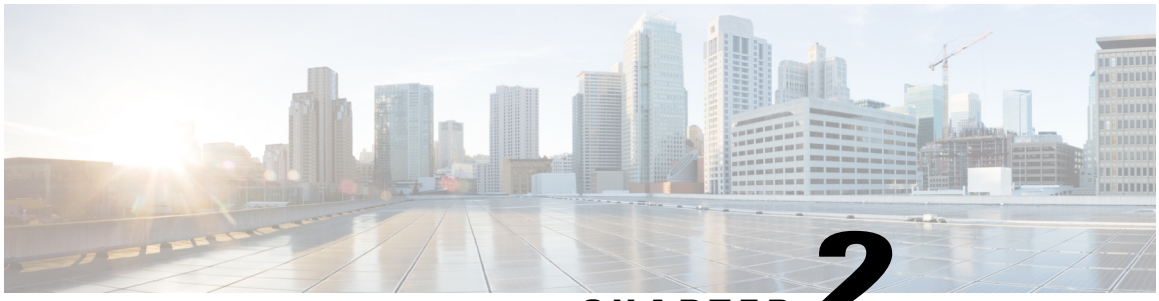
MIBs	MIBs Link
CISCO-RTTMON-MIB	To locate and download MIBs for selected platforms, Cisco IOS releases, and feature sets, use Cisco MIB Locator found at the following URL: http://www.cisco.com/go/mibs

RFCs

RFCs	Title
No new or modified RFCs are supported by this feature, and support for existing RFCs has not been modified by this feature.	--

Technical Assistance

Description	Link
The Cisco Support and Documentation website provides online resources to download documentation, software, and tools. Use these resources to install and configure the software and to troubleshoot and resolve technical issues with Cisco products and technologies. Access to most tools on the Cisco Support and Documentation website requires a Cisco.com user ID and password.	http://www.cisco.com/cisco/web/support/index.html



CHAPTER 2

Configuring IP SLAs UDP Jitter Operations

This document describes how to configure an IP Service Level Agreements (SLAs) UDP jitter operation to analyze round-trip delay, one-way delay, one-way jitter, one-way packet loss, and connectivity in networks that carry UDP traffic in IPv4 or IPv6 networks. This module also explains how the data gathered using the UDP jitter operation can be displayed and analyzed using Cisco software commands.

Finding Feature Information

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Prerequisites for IP SLAs UDP Jitter Operations

- Time synchronization, such as that provided by the Network Time Protocol (NTP), is required between the source and the target device to provide accurate one-way delay (latency) measurements. To configure NTP on source and target devices, perform the tasks in the “Performing Basic System Management” chapter of the *Basic System Management Configuration Guide*. Time synchronization is not required

for one-way jitter and packet loss measurements. If time is not synchronized between source and target devices, one-way jitter and packet loss data are returned, but values of “0” are returned for the one-way delay measurements provided by the UDP jitter operation.

- Before configuring any IP Service Level Agreements (SLAs) application, use the **show ip sla application** command to verify that the operation type is supported on the software image.

Information About IP SLAs UDP Jitter Operations

IP SLAs UDP Jitter Operation

The IP Service Level Agreements (SLAs) UDP jitter operation diagnoses network suitability for real-time traffic applications such as VoIP, video over IP, or real-time conferencing.

Jitter means inter-packet delay variance. When multiple packets are sent consecutively from a source to a destination, for example, 10 ms apart, and if the network is behaving ideally, the destination should receive the packets 10 ms apart. But if there are delays in the network (like queuing, arriving through alternate routes, and so on) the arrival delay between packets might be greater than or less than 10 ms. Using this example, a positive jitter value indicates that packets arrived greater than 10 ms apart. If packets arrive 12 ms apart, then positive jitter is 2 ms; if packets arrive 8 ms apart, negative jitter is 2 ms. For delay-sensitive networks like VoIP, positive jitter values are undesirable, and a jitter value of 0 is ideal.

However, the IP SLAs UDP jitter operation does more than just monitor jitter. As the UDP jitter operation includes data returned by the IP SLAs UDP operation, the UDP jitter operation can be used as a multipurpose data gathering operation. The packets that IP SLAs generate carry packet-sending and receiving sequence information, and sending and receiving time stamps from the source and the operational target. Based on this information, UDP jitter operations are capable of measuring the following:

- Per-direction jitter (source to destination and destination to source)
- Per-direction packet loss
- Per-direction delay (one-way delay)
- Round-trip delay (average round-trip time)

As paths for sending and receiving data may be different (asymmetric), the per-direction data allows you to more readily identify where congestion or other problems are occurring in the network.

The UDP jitter operation functions by generating synthetic (simulated) UDP traffic. Asymmetric probes support custom-defined packet sizes per direction with which different packet sizes can be sent in request packets (from the source device to the destination device) and in response packets (from the destination device to the source device).

The UDP jitter operation sends N number of UDP packets, each of size S, T milliseconds apart, from a source device to a destination device, at a given frequency of F. In response, UDP packets of size P is sent from the destination device to the source device. By default, ten packet frames (N), each with a payload size of 10 bytes (S), are generated every 10 ms (T), and the operation is repeated every 60 seconds (F). Each of these parameters is user-configurable, so as to best simulate the IP service that you provide, as shown in the table below.

Table 1: UDP Jitter Operation Parameters

UDP Jitter Operation Parameter	Default	Configuration Commands
Number of packets (N)	10 packets	**udp-jitter num-packets**
Payload size per request packet (S)	10 bytes	**request-data-size**
Payload size per response packet (P)	The default response data size varies depending on the type of IP SLAs operation configured. **Note** If the **response-data-size** command is not configured, then the response data size value is the same as the request data size value.	**response-data-size**
Time between packets, in milliseconds (T)	10 ms	**udp-jitter interval**
Elapsed time before the operation repeats, in seconds (F)	60 seconds	**frequency (IP SLA)**

The IP SLAs operations function by generating synthetic (simulated) network traffic. A single IP SLAs operation (for example, IP SLAs operation 10) repeats at a given frequency for the lifetime of the operation.

How to Configure IP SLAs UDP Jitter Operations

Configuring the IP SLAs Responder on a Destination Device

Note A responder should not configure a permanent port for a sender. If the responder configures a permanent port for a sender, even if the packets are successfully sent (no timeout or packet-loss issues), the jitter value is zero.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. Enter one of the following commands:
   - **ip sla responder**
   - **ip sla responder udp-echo ipaddress** *ip-address* **port** *port*
4. **end**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Device> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Device# configure terminal`	Enters global configuration mode.

Step 3	Enter one of the following commands:
	• **ip sla responder**
	• **ip sla responder udp-echo ipaddress** *ip-address* **port** *port*
	
	Example:
	`Device(config)# ip sla responder`
	
	`Device(config)# ip sla responder udp-echo ipaddress 192.0.2.132 port 5000`
		(Optional) Temporarily enables IP SLAs responder functionality on a Cisco device in response to control messages from the source.
		(Optional; required only if protocol control is disabled on the source.) Enables IP SLAs responder functionality on the specified IP address and port.
		• Protocol control is enabled by default.

Step 4	**end** **Example:** `Device(config)# end`	Exits global configuration mode and returns to privileged EXEC mode.

Configuring and Scheduling a UDP Jitter Operation on a Source Device

Perform only one of the following tasks:

- Configuring a Basic UDP Jitter Operation on a Source Device
- Configuring a UDP Jitter Operation with Additional Characteristics

Configuring a Basic UDP Jitter Operation on a Source Device

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **ip sla** *operation-number*
4. **udp-jitter** {*destination-ip-address* | *destination-hostname*} *destination-port* [**source-ip** {*ip-address* | *hostname*}] [**source-port** *port-number*] [**control** {**enable** | **disable**}] [**num-packets** *number-of-packets*] [**interval** *interpacket-interval*]
5. **frequency** *seconds*
6. **end**
7. **show ip sla configuration** [*operation-number*]

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Device> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Device# configure terminal`	Enters global configuration mode.
Step 3	**ip sla** *operation-number* **Example:** `Device(config)# ip sla 10`	Starts configuring an IP SLAs operation and enters IP SLA configuration mode.
Step 4	**udp-jitter** {*destination-ip-address* | *destination-hostname*} *destination-port* [**source-ip** {*ip-address* | *hostname*}] [**source-port** *port-number*]	Configures the IP SLAs operation as a UDP jitter operation and enters UDP jitter configuration mode.

	Command or Action	Purpose
	[**control** {**enable** | **disable**}] [**num-packets** *number-of-packets*] [**interval** *interpacket-interval*] **Example:** `Device(config-ip-sla)# udp-jitter 192.0.2.135 5000`	• Use the **control disable** keyword combination only if you disable the IP SLAs control protocol on both source and destination devices.
Step 5	**frequency** *seconds* **Example:** `Device(config-ip-sla-jitter)# frequency 30`	(Optional) Sets the rate at which a specified IP SLAs operation repeats.
Step 6	**end** **Example:** `Device(config-ip-sla-jitter)# end`	Exits UDP Jitter configuration mode and returns to privileged EXEC mode.
Step 7	**show ip sla configuration** [*operation-number*] **Example:** `Device# show ip sla configuration 10`	(Optional) Displays configuration values including all defaults for all IP SLAs operations or a specified operation.

What to Do Next

To configure the percentile option for your operation, see the "Configuring the IP SLAs—Percentile Support for Filtering Outliers" module.

Configuring a UDP Jitter Operation with Additional Characteristics

Note

- The IP Service Level Agreements (SLAs) UDP jitter operation does not support the IP SLAs History feature because of the large volume of data involved with UDP jitter operations. This means that the following commands are not supported for UDP jitter operations: **history buckets-kept**, **history filter**, **history lives-kept**, **samples-of-history-kept**, and **show ip sla history**.
- The MIB used by IP SLAs (CISCO-RTTMON-MIB) limits the hours-of-statistics kept for the UDP jitter operation to two hours. Configuring a larger value using the **history hours-of-statistics** *hours* global configuration change does not increase the value beyond two hours. However, the Data Collection MIB can be used to collect historical data for the operation. For more information, see the CISCO-DATA-COLLECTION-MIB.

Before You Begin

Before configuring a UDP jitter operation on a source device, the IP SLAs Responder must be enabled on the target device (the operational target). The IP SLAs Responder is available only on Cisco IOS software-based devices. To enable the Responder, perform the task in the "Configuring the IP SLAs Responder on the Destination Device" section.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **ip sla** *operation-number*
4. **udp-jitter** {*destination-ip-address* | *destination-hostname*} *destination-port* [**source-ip** {*ip-address* | *hostname*}] [**source-port** *port-number*] [**control** {**enable** | **disable**}] [**num-packets** *number-of-packets*] [**interval** *interpacket-interval*]
5. **history distributions-of-statistics-kept** *size*
6. **history enhanced** [**interval** *seconds*] [**buckets** *number-of-buckets*]
7. **frequency** *seconds*
8. **history hours-of-statistics-kept** *hours*
9. **owner** *owner-id*
10. **request-data-size** *bytes*
11. **response-data-size** *bytes*
12. **history statistics-distribution-interval** *milliseconds*
13. **tag** *text*
14. **threshold** *milliseconds*
15. **timeout** *milliseconds*
16. Enter one of the following commands:
    - **tos** *number*
    - **traffic-class** *number*
17. **flow-label** *number*
18. **verify-data**
19. **vrf** *vrf-name*
20. **end**
21. **show ip sla configuration** [*operation-number*]

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Device> enable`	Enables privileged EXEC mode. • Enter your password if prompted.

	Command or Action	Purpose
Step 2	**configure terminal** **Example:** `Device# configure terminal`	Enters global configuration mode.
Step 3	**ip sla** *operation-number* **Example:** `Device(config)# ip sla 10`	Begins configuration for an IP SLAs operation and enters IP SLA configuration mode.
Step 4	**udp-jitter** {*destination-ip-address* | *destination-hostname*} *destination-port* [**source-ip** {*ip-address* | *hostname*}] [**source-port** *port-number*] [**control** {**enable** | **disable**}] [**num-packets** *number-of-packets*] [**interval** *interpacket-interval*] **Example:** `Device(config-ip-sla)# udp-jitter 192.0.2.134 5000`	Configures the IP SLAs operation as a UDP jitter operation and enters UDP jitter configuration mode. • Use the **control disable** keyword combination only if you disable the IP SLAs control protocol on both source and target devices.
Step 5	**history distributions-of-statistics-kept** *size* **Example:** `Device(config-ip-sla-jitter)# history distributions-of-statistics-kept 5`	(Optional) Sets the number of statistics distributions kept per hop for an IP SLAs operation.
Step 6	**history enhanced** [**interval** *seconds*] [**buckets** *number-of-buckets*] **Example:** `Device(config-ip-sla-jitter)# history enhanced interval 900 buckets 100`	(Optional) Enables enhanced history gathering for an IP SLAs operation.
Step 7	**frequency** *seconds* **Example:** `Device(config-ip-sla-jitter)# frequency 30`	(Optional) Sets the rate at which a specified IP SLAs operation repeats.
Step 8	**history hours-of-statistics-kept** *hours* **Example:** `Device(config-ip-sla-jitter)# history hours-of-statistics-kept 4`	(Optional) Sets the number of hours for which statistics are maintained for an IP SLAs operation.

	Command or Action	Purpose
Step 9	**owner** *owner-id* **Example:** `Device(config-ip-sla-jitter)# owner admin`	(Optional) Configures the Simple Network Management Protocol (SNMP) owner of an IP SLAs operation.
Step 10	**request-data-size** *bytes* **Example:** `Device(config-ip-sla-jitter)# request-data-size 64`	(Optional) Sets the protocol data size in the payload of an IP SLAs operation request packet.
Step 11	**response-data-size** *bytes* **Example:** `Device(config-ip-sla-jitter)# response-data-size 25`	(Optional) Sets the protocol data size in the payload of an IP SLAs operation response packet.
Step 12	**history statistics-distribution-interval** *milliseconds* **Example:** `Device(config-ip-sla-jitter)# history statistics-distribution-interval 10`	(Optional) Sets the time interval for each statistics distribution kept for an IP SLAs operation.
Step 13	**tag** *text* **Example:** `Device(config-ip-sla-jitter)# tag TelnetPollServer1`	(Optional) Creates a user-specified identifier for an IP SLAs operation.
Step 14	**threshold** *milliseconds* **Example:** `Device(config-ip-sla-jitter)# threshold 10000`	(Optional) Sets the upper threshold value for calculating network monitoring statistics created by an IP SLAs operation.
Step 15	**timeout** *milliseconds* **Example:** `Device(config-ip-sla-jitter)# timeout 10000`	(Optional) Sets the amount of time an IP SLAs operation waits for a response from its request packet.
Step 16	Enter one of the following commands: • **tos** *number* • **traffic-class** *number*	(Optional) Defines the ToS byte in the IPv4 header of an IP SLAs operation. or (Optional) Defines the traffic class byte in the IPv6 header for a supported IP SLAs operation.

	Command or Action	Purpose

	Example:
	`Device(config-ip-sla-jitter)# tos 160`
	
	`Device(config-ip-sla-jitter)# traffic-class 160`	

Step 17	**flow-label** *number* **Example:** `Device(config-ip-sla-jitter)# flow-label 112233`	(Optional) Defines the flow label field in the IPv6 header for a supported IP SLAs operation.
Step 18	**verify-data** **Example:** `Device(config-ip-sla-jitter)# verify-data`	(Optional) Causes an IP SLAs operation to check each reply packet for data corruption.
Step 19	**vrf** *vrf-name* **Example:** `Device(config-ip-sla-jitter)# vrf vpn-A`	(Optional) Allows monitoring within Multiprotocol Label Switching (MPLS) VPNs using IP SLAs operations.
Step 20	**end** **Example:** `Device(config-ip-sla-jitter)# end`	Exits UDP jitter configuration mode and returns to privileged EXEC mode.
Step 21	**show ip sla configuration** [*operation-number*] **Example:** `Device# show ip sla configuration 10`	(Optional) Displays configuration values including all defaults for all IP SLAs operations or a specified operation.

What to Do Next

To configure the percentile option for your operation, see the "Configuring the IP SLAs—Percentile Support for Filtering Outliers" module.

Scheduling IP SLAs Operations

Before You Begin

- All IP Service Level Agreements (SLAs) operations to be scheduled must be already configured.

- The frequency of all operations scheduled in a multioperation group must be the same.
- The list of one or more operation ID numbers to be added to a multioperation group must be limited to a maximum of 125 characters in length, including commas (,).

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. Enter one of the following commands:
   - **ip sla schedule** *operation-number* [**life** {**forever** | *seconds*}] [**start-time** {[*hh*:*mm*:*ss*] [*month day* | *day month*] | **pending** | **now** | **after** *hh*:*mm*:*ss*}] [**ageout** *seconds*] [**recurring**]
   - **ip sla group schedule** *group-operation-number operation-id-numbers* {**schedule-period** *schedule-period-range* | **schedule-together**} [**ageout** *seconds*] [**frequency** *group-operation-frequency*] [**life** {**forever** | *seconds*}] [**start-time** {*hh*:*mm* [:*ss*] [*month day* | *day month*] | **pending** | **now** | **after** *hh*:*mm* [:*ss*]}]
4. **end**
5. **show ip sla group schedule**
6. **show ip sla configuration**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Device> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Device# configure terminal`	Enters global configuration mode.
Step 3	Enter one of the following commands: • **ip sla schedule** *operation-number* [**life** {**forever**	*seconds*}] [**start-time** {[*hh*:*mm*:*ss*] [*month day*	*day month*]	**pending**	**now**	**after** *hh*:*mm*:*ss*}] [**ageout** *seconds*] [**recurring**] • **ip sla group schedule** *group-operation-number operation-id-numbers* {**schedule-period** *schedule-period-range*	**schedule-together**} [**ageout** *seconds*] [**frequency** *group-operation-frequency*] [**life** {**forever**	*seconds*}] [**start-time** {*hh*:*mm* [:*ss*] [*month day*	*day month*]	**pending**	**now**	**after** *hh*:*mm* [:*ss*]}]	• Configures the scheduling parameters for an individual IP SLAs operation. • Specifies an IP SLAs operation group number and the range of operation numbers for a multioperation scheduler.

	Command or Action	Purpose

	Example:
	`Device(config)# ip sla schedule 10 life forever start-time now`
	`Device(config)# ip sla group schedule 10 schedule-period frequency`
	`Device(config)# ip sla group schedule 1 3,4,6-9 life forever start-time now`
	`Device(config)# ip sla schedule 1 3,4,6-9 schedule-period 50 frequency range 80-100`	

Step 4	**end** **Example:** `Device(config)# end`	Exits global configuration mode and returns to privileged EXEC mode.
Step 5	**show ip sla group schedule** **Example:** `Device# show ip sla group schedule`	(Optional) Displays IP SLAs group schedule details.
Step 6	**show ip sla configuration** **Example:** `Device# show ip sla configuration`	(Optional) Displays IP SLAs configuration details.

Troubleshooting Tips

- If the IP Service Level Agreements (SLAs) operation is not running and not generating statistics, add the **verify-data** command to the configuration (while configuring in IP SLA configuration mode) to enable data verification. When data verification is enabled, each operation response is checked for corruption. Use the **verify-data** command with caution during normal operations because it generates unnecessary overhead.
- Use the **debug ip sla trace** and **debug ip sla error** commands to help troubleshoot issues with an IP SLAs operation.

What to Do Next

To add proactive threshold conditions and reactive triggering for generating traps (or for starting another operation) to an IP Service Level Agreements (SLAs) operation, see the "Configuring Proactive Threshold Monitoring" section.

Verifying IP SLAs UDP Jitter Operations

SUMMARY STEPS

1. **enable**
2. **show ip sla configuration**
3. **show ip sla group schedule**
4. **show ip sla statistics**
5. **show ip sla statistics 2 details**

DETAILED STEPS

Step 1 **enable**
Enables privileged EXEC mode.

- Enter your password if prompted.

Example:

```
Device> enable
```

Step 2 **show ip sla configuration**
Displays IP SLAs configuration details.

Example:

```
Device# show ip sla configuration

IP SLAs Infrastructure Engine-III
Entry number: 5
Owner: ownername
Tag: text
Operation timeout (milliseconds): 9999
Type of operation to perform: udp-jitter
Target address/Source address: 192.0.2.115/0.0.0.0
Target port/Source port: 5/0
Type Of Service parameter: 0x5
Request size (ARR data portion): 100
Response size (ARR data portion): 200
Packet Interval (milliseconds)/Number of packets: 20/10
Verify data: No
Operation Stats Precision : microseconds
Timestamp Location Optimization: enabled
Operation Packet Priority : high
NTP Sync Tolerance : 0 percent
Vrf Name:
```

```
Control Packets: enabled
```

Step 3 **show ip sla group schedule**
Displays IP SLAs group schedule details.

Example:

```
Device# show ip sla group schedule

Group Entry Number: 1
Probes to be scheduled: 6-9,3-4
Total number of probes: 6
Schedule period: 10
Mode: even
Group operation frequency: Equals schedule period
Status of entry (SNMP RowStatus): Active
Next Scheduled Start Time: Pending trigger
Life (seconds): 3600
Entry Ageout (seconds): never
```

Step 4 **show ip sla statistics**
Displays IP SLAs statistics.

Example:

```
Device# show ip sla statistics

Type of operation: udp-jitter
Packet Loss Values:
Loss Source to Destination: 19
Source to Destination Loss Periods Number: 19
Source to Destination Loss Period Length Min/Max: 1/1
Source to Destination Inter Loss Period Length Min/Max: 1/546
Loss Destination to Source: 0
Destination to Source Loss Periods Number: 0
Destination to Source Loss Period Length Min/Max: 0/0
Destination to Source Inter Loss Period Length Min/Max: 0/0
Out Of Sequence: 0 Tail Drop: 0
Packet Late Arrival: 0 Packet Skipped: 0
```

- udp-jitter has the ability to detect in which direction a packet was lost in. It also calculates statistics about the periods of packet loss
- Loss Source to Destination: 19—Indicates that 19 packets were sent from the sender but never reached the responder.
- Source to Destination Loss Periods Number: 19—Indicates that there were 19 incidents of packet loss (an incident of packet loss is a period where packets are lost, irrespective of the actual number of lost packets.)
- Source to Destination Loss Period Length Min/Max: 1/1—indicates that all packets lost in this direction are isolated; there are no instances of multiple lost packets back-to-back.
- Source to Destination Inter Loss Period Length Min/Max: 1/546—indicates that the minimum gap between lost packets is 1, and the maximum gap between successive packet losses is 546 successfully sent packets.

Step 5 **show ip sla statistics 2 details**
Displays IPSLAs latest operation statistics

Example:

```
Device# show ip sla statistics 2 details

IPSLA operation id: 2
Type of operation: udp-jitter
Latest RTT: 1 milliseconds
Latest operation start time: 07:45:28 GMT Thu Aug 28 2014
Latest operation return code: OK
Over thresholds occurred: FALSE
RTT Values:
Number Of RTT: 10 RTT Min/Avg/Max: 1/1/1 milliseconds
Latency one-way time:
Number of Latency one-way Samples: 6
Source to Destination Latency one way Min/Avg/Max: 1/1/1 milliseconds
Destination to Source Latency one way Min/Avg/Max: 0/0/0 milliseconds
Source to Destination Latency one way Sum/Sum2: 6/6
Destination to Source Latency one way Sum/Sum2: 0/0
Jitter Time:
Number of SD Jitter Samples: 9
Number of DS Jitter Samples: 9
Source to Destination Jitter Min/Avg/Max: 0/1/1 milliseconds
Destination to Source Jitter Min/Avg/Max: 0/0/0 milliseconds
Source to destination positive jitter Min/Avg/Max: 1/1/1 milliseconds
Source to destination positive jitter Number/Sum/Sum2: 3/3/3
Source to destination negative jitter Min/Avg/Max: 1/1/1 milliseconds
Source to destination negative jitter Number/Sum/Sum2: 3/3/3
Destination to Source positive jitter Min/Avg/Max: 0/0/0 milliseconds
Destination to Source positive jitter Number/Sum/Sum2: 0/0/0
Destination to Source negative jitter Min/Avg/Max: 0/0/0 milliseconds
Destination to Source negative jitter Number/Sum/Sum2: 0/0/0
Interarrival jitterout: 0 Interarrival jitterin: 0
Jitter AVG: 1
Over Threshold:
Number Of RTT Over Threshold: 0 (0%)
Packet Loss Values:
Loss Source to Destination: 0
Source to Destination Loss Periods Number: 0
Source to Destination Loss Period Length Min/Max: 0/0
Source to Destination Inter Loss Period Length Min/Max: 0/0
Loss Destination to Source: 0
Destination to Source Loss Periods Number: 0
Destination to Source Loss Period Length Min/Max: 0/0
Destination to Source Inter Loss Period Length Min/Max: 0/0
Out Of Sequence: 0 Tail Drop: 0 Packet Late Arrival: 0
Packet Skipped: 0
Voice Score Values:
Calculated Planning Impairment Factor (ICPIF): 0
Mean Opinion Score (MOS): 0
Number of successes: 2
Number of failures: 0
Operation time to live: Forever
Operational state of entry: Active
Last time this entry was reset: Never
```

Configuration Examples for IP SLAs UDP Jitter Operations

Example: Configuring a UDP Jitter Operation

In the following example, two operations are configured as UDP jitter operations, with operation 2 starting five seconds after the first operation. Both operations will run indefinitely.

```
configure terminal
 ip sla 1
  udp-jitter 192.0.2.115 65051 num-packets 20
  request-data-size 160
  tos 128
  frequency 30
 ip sla schedule 1 start-time after 00:05:00
 ip sla 2
  udp-jitter 192.0.2.115 65052 num-packets 20 interval 10
  request-data-size 20
  tos 64
  frequency 30
 ip sla schedule 2 start-time after 00:05:05
```

Enter the following command on the target (destination) device to temporarily enable the IP SLAs responder functionality on a Cisco device in response to control messages from the source device.

```
ip sla responder
```

Additional References for IP SLAs UDP Jitter Operations

Related Documents

Related Topic	Document Title
Cisco IOS commands	Cisco IOS Master Command List, All Releases
Cisco IOS IP SLAs commands	Cisco IOS IP SLAs Command Reference

MIBs

MIBs	MIBs Link
• CISCO-DATA-COLLECTION-MIB • CISCO-RTTMON-MIB • IPV6-FLOW-LABEL-MIB	To locate and download MIBs for selected platforms, Cisco IOS releases, and feature sets, use Cisco MIB Locator found at the following URL: http://www.cisco.com/go/mibs

Technical Assistance

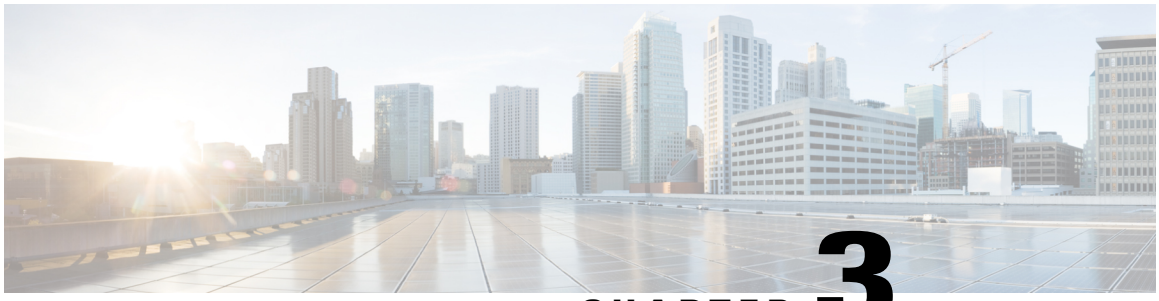
Description	Link
The Cisco Support and Documentation website provides online resources to download documentation, software, and tools. Use these resources to install and configure the software and to troubleshoot and resolve technical issues with Cisco products and technologies. Access to most tools on the Cisco Support and Documentation website requires a Cisco.com user ID and password.	http://www.cisco.com/cisco/web/support/index.html

Feature Information for IP SLAs UDP Jitter Operations

Table 2: Feature Information for the IP SLAs UDP Jitter Operation

Feature Name	Releases	Feature Information
IP SLAs—UDP Jitter Operation	Cisco IOS XE 3.2SE	The IP SLAs UDP jitter operation allows you to measure round-trip delay, one-way delay, one-way jitter, one-way packet loss, and connectivity in networks that carry UDP traffic. In Cisco IOS XE Release 3.2SE, this feature was supported on the following platforms: • Catalyst 3650 Series Switches • Catalyst 3850 Series Switches • Cisco 5760 Wireless LAN Controller

Feature Name	Releases	Feature Information
IP SLAs for IPv6 (UDP Jitter, UDP Echo, ICMP Echo, TCP Connect)	Cisco IOS XE 3.2SE	The IP SLAs for IPv6 (UDP Jitter, UDP Echo, ICMP Echo, TCP Connect) feature adds support for operability in IPv6 networks. In Cisco IOS XE Release 3.2SE, this feature was supported on the following platforms: • Catalyst 3650 Series Switches • Catalyst 3850 Series Switches • Cisco 5760 Wireless LAN Controller
IP SLAs—Asymmetric Probe Support for UDP Jitter	Cisco IOS XE 3.2SE	The IP SLAs—Asymmetric Probe Support for UDP Jitter feature supports the configuration of custom-defined packet sizes in response packets. In Cisco IOS XE Release 3.2SE, this feature was supported on the following platforms: • Catalyst 3650 Series Switches • Catalyst 3850 Series Switches • Cisco 5760 Wireless LAN Controller The following command was introduced: **response-data-size**.



CHAPTER 3

Configuring IP SLAs UDP Jitter Operations for VoIP

This document describes how to configure an IP Service Level Agreements (SLAs) User Datagram Protocol (UDP) jitter operation to proactively monitor Voice over IP (VoIP) quality levels in your network, allowing you to guarantee VoIP quality levels to your users in IPv4 or IPv6 networks. The IP SLAs VoIP UDP jitter operation accurately simulates VoIP traffic using common codecs and calculates consistent voice quality scores (MOS and ICPIF) between Cisco devices in the network.

Note The term "Voice" in this document should be taken to mean any Internet telephony applications. The term "Voice over IP" can include the transmission of multimedia (both voice and video) over IP networks.

Finding Feature Information

Your software release may not support all the features documented in this module. For the latest caveats and feature information, see Bug Search Tool and the release notes for your platform and software release. To find information about the features documented in this module, and to see a list of the releases in which each feature is supported, see the feature information table.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to www.cisco.com/go/cfn. An account on Cisco.com is not required.

Restrictions for IP SLAs UDP Jitter Operations for VoIP

- This feature uses UDP traffic to generate approximate Voice over IP scores. It does not provide support for the Real-Time Transport Protocol (RTP).
- ICPIF and MOS values provided by this feature, while consistent within IP SLAs, are estimates only and are intended only for relative comparisons. The values may not match values determined using other methods.
- Predictions of customer opinion (such as those listed for the E-Model transmission rating factor R and derived Mean Opinion Scores) determined by any method are intended only for transmission planning and analysis purposes and should not be interpreted as reflecting actual customer opinions.

Information About IP SLAs UDP Jitter Operations for VoIP

The Calculated Planning Impairment Factor (ICPIF)

The ICPIF originated in the 1996 version of ITU-T recommendation G.113, "Transmission impairments," as part of the formula *Icpif = Itot - A*. ICPIF is actually an acronym for "(Impairment) Calculated Planning Impairment Factor," but should be taken to simply mean the "calculated planning impairment factor." The ICPIF attempts to quantify, for comparison and planning purposes, the key impairments to voice quality that are encountered in the network.

The ICPIF is the sum of measured impairment factors (total impairments, or *Itot*) minus a user-defined access Advantage Factor (*A*) that is intended to represent the user's expectations, based on how the call was placed (for example, a mobile call versus a land-line call). In its expanded form, the full formula is expressed as:

Icpif = Io + Iq + Idte + Idd + Ie - A

where

- *Io* represents impairments caused by non-optimal loudness rating,
- *Iq* represents impairments caused by PCM quantizing distortion,
- *Idte* represents impairments caused by talker echo,
- *Idd* represents impairments caused by one-way transmission times (one-way delay),
- *Ie* represents impairments caused by equipment effects, such as the type of codec used for the call and packet loss, and
- *A* represents an access Advantage Factor (also called the user Expectation Factor) that compensates for the fact that users may accept some degradation in quality in return for ease of access.

ICPIF values are expressed in a typical range of 5 (very low impairment) to 55 (very high impairment). ICPIF values numerically less than 20 are generally considered "adequate." While intended to be an objective measure of voice quality, the ICPIF value is also used to predict the subjective effect of combinations of impairments. The table below, taken from G.113 (02/96), shows how sample ICPIF values are expected to correspond to subjective quality judgement.

Table 3: Quality Levels as a Function of Total Impairment Factor ICPIF

Upper Limit for ICPIF	Speech Communication Quality
5	Very good
10	Good
20	Adequate
30	Limiting case
45	Exceptional limiting case
55	Customers likely to react strongly (complaints, change of network operator)

For further details on the ICPIF, see the 1996 version of the G.113 specification.

Note The latest version of the ITU-T G.113 Recommendation (2001), no longer includes the ICPIF model. Instead, it refers implementers to G.107: "The Impairment Factor method, used by the E-model of ITU-T G.107, is now recommended. The earlier method that used Quantization Distortion Units is no longer recommended." The full E-Model (also called the ITU-T Transmission Rating Model), expressed as $R = Ro - Is - Id - Ie + A$, provides the potential for more accurate measurements of call quality by refining the definitions of impairment factors (see the 2003 version of the G.107 for details). Though the ICPIF shares terms for impairments with the E-Model, the two models should not be confused. The IP SLAs VoIP UDP Operation feature takes advantage of observed correspondences between the ICPIF, transmission rating factor R, and MOS values, but does not yet support the E-Model.

IP SLAs uses a simplified ICPIF formula, defined in more detail later in this document.

Mean Opinion Scores (MOS)

The quality of transmitted speech is a subjective response of the listener. Each codec used for transmission of Voice over IP provides a certain level of quality. A common benchmark used to determine the quality of sound produced by specific codecs is MOS. With MOS, a wide range of listeners have judged the quality of voice samples sent using particular codecs, on a scale of 1 (poor quality) to 5 (excellent quality). The opinion scores are averaged to provide the mean for each sample. The table below shows MOS ratings and the corresponding description of quality for each value.

Table 4: MOS Ratings

Score	Quality	Description of Quality Impairment
5	Excellent	Imperceptible
4	Good	Just perceptible, but not annoying

Score	Quality	Description of Quality Impairment
3	Fair	Perceptible and slightly annoying
2	Poor	Annoying but not objectionable
1	Bad	Very annoying and objectionable

As the MOS ratings for codecs and other transmission impairments are known, an estimated MOS can be computed and displayed based on measured impairments. This estimated value is designated as MOS-CQE (Mean Opinion Score; Conversational Quality, Estimated) by the ITU in order to distinguish it from objective or subjective MOS values (see *P.800.1 Mean Opinion Score (MOS) terminology - ITU* for details).

Voice Performance Monitoring Using IP SLAs

One of the key metrics in measuring voice and video quality over an IP network is jitter. Jitter is the name used to indicate the variation in delay between arriving packets (inter-packet delay variance). Jitter affects voice quality by causing uneven gaps in the speech pattern of the person talking. Other key performance parameters for voice and video transmission over IP networks include latency (delay) and packet loss. IP SLAs is an embedded active monitoring feature of Cisco software that provides a means for simulating and measuring these parameters in order to ensure your network is meeting or exceeding service-level agreements with your users.

IP SLAs provides a UDP jitter operation, which consists of UDP probe packets sent across the network from an origin device to a specific destination (called the operational target). This synthetic traffic is used to record the amount of jitter for the connection, as well as the round-trip time, per-direction packet loss, and one-way delay time (one-way latency). The term “synthetic traffic” indicates that the network traffic is simulated; that is, the traffic is generated by IP SLAs. Data, in the form of collected statistics, can be displayed for multiple tests over a user-defined period of time, allowing you to see, for example, how the network performs at different times of the day, or over the course of a week. The jitter probe has the advantage of utilizing the IP SLAs Responder to provide minimal latency at the receiving end.

The IP SLAs VoIP UDP jitter operation modifies the standard UDP jitter operation by adding the capability to return MOS and ICPIF scores in the data collected by the operation, in addition to the metrics already gathered by the UDP jitter operation. This VoIP-specific implementation provides even more useful information in determining the performance of your VoIP network, thereby improving your ability to perform network assessment, troubleshooting, and health monitoring.

Codec Simulation Within IP SLAs

The IP SLAs VoIP UDP jitter operation computes statistics by sending n UDP packets, each of size s, sent t milliseconds apart, from a given source device to a given target device, at a given frequency f. The target device must be running the Cisco IP SLAs Responder in order to process the probe operations.

To generate MOS and ICPIF scores, you must specify the codec type used for the connection when configuring the VoIP UDP jitter operation. Based on the type of codec you configure for the operation, the number of packets (n), the size of each payload (s), the inter-packet time interval (t), and the operational frequency (f) will be auto-configured with default values. However, you are given the option, if needed, to manually configure these parameters in the syntax of the**udp-jitter** command.

The table below shows the default parameters that are configured for the operation by codec.

Table 5: Default VoIP UDP Jitter Operation Parameters by Codec

Codec	Default Request Size (Packet Payload) (s)	Default Interval Between Packets (t)	Default Number of Packets (n)	Frequency of Probe Operations (f)
G.711 mu-Law (g711ulaw)	160 + 12 RTP bytes	20 ms	1000	Once every 1 minute
G.711 A-Law (g711alaw)	160 + 12 RTP bytes	20 ms	1000	Once every 1 minute
G.729A (g729a)	20 + 12 RTP bytes	20 ms	1000	Once every 1 minute

For example, if you configure the VoIP UDP jitter operation to use the characteristics for the g711ulaw codec, by default a probe operation will be sent once a minute (**f**). Each probe operation would consist of 1000 packets (**n**), with each packet containing 180 bytes of synthetic data (**s**), sent 20 milliseconds apart (**t**).

The IP SLAs ICPIF Value

ICPIF value computation with Cisco software is based primarily on the two main factors that can impair voice quality: delayed packets and lost packets. Because packet delay and packet loss can be measured by IP SLAs, the full ICPIF formula, *Icpif = Io + Iq + Idte + Idd + Ie - A*, is simplified by assuming the values of *Io* , *Iq* , and *Idte* are zero, resulting in the following formula:

Total Impairment Factor (Icpif) = Delay Impairment Factor (Idd) + Equipment Impairment Factor (Ie) - Expectation/Advantage Factor (A)

This means that the ICPIF value is computed by adding a Delay Impairment Factor, which is based on a measurement of delayed packets, and an Equipment Impairment Factor, which is based on a measurement of lost packets. From this sum of the total impairments measured in the network, an impairment variable (the Expectation Factor) is subtracted to yield the ICPIF.

This is the same formula used by Cisco Gateways to calculate the ICPIF for received VoIP data streams.

The Delay Impairment Factor

The Delay Impairment Factor (*Idd*) is a number based on two values. One value is fixed and is derived using the static values (as defined in the ITU standards) for Codec Delay, Look Ahead Delay, and Digital Signal Processing (DSP) Delay. The second value is variable and is based on the measured one-way delay (round-trip time measurement divided by 2). The one-way delay value is mapped to a number using a mapping table that is based on a G.107 (2002 version) analytic expression. The table below shows sample correspondences between the one-way delay measured by IP SLAs and Delay Impairment Factor values.

Table 6: Sample Correspondence of One-Way Delay to ICPIF Delay Impairment

One-Way Delay (ms)	Delay Impairment Factor
50	1
100	2
150	4
200	7

The Equipment Impairment Factor

The Equipment Impairment Factor (*Ie*) is a number based on the amount of measured packet loss. The amount of measured packet loss, expressed as a percentage of total number of packets sent, corresponds an Equipment Impairment Factor that is defined by codec. The table below shows sample correspondences between the packet loss measured by IP SLAs and Equipment Impairment Factor values.

Table 7: Sample Correspondence of Measured Packet Loss to ICPIF Equipment Impairment

Packet Loss (as a percentage of total number of packets sent)	Equipment Impairment Value for PCM (G.711) Codecs	Equipment Impairment Value for the CS-ACELP (G.729A) Codec
2%	12	20
4%	22	30
6%	28	38
8%	32	42

The Expectation Factor

The Expectation Factor, also called the Advantage Factor (*A*), is intended to represent the fact that users may accept some degradation in quality in return for ease of access. For example, a mobile phone user in a hard-to-reach location may have an expectation that the connection quality will not be as good as a traditional land-line connection. This variable is also called the Advantage Factor (short for Access Advantage Factor) because it attempts to balance an increased access advantage against a decline in voice quality.

The table below, adapted from ITU-T Rec. G.113, defines a set of provisional maximum values for *A* in terms of the service provided.

Table 8: Advantage Factor Recommended Maximum Values

Communication Service	Advantage / Expectation Factor: Maximum value of A
Conventional wire-line (land-line)	0

Communication Service	Advantage / Expectation Factor: Maximum value of A
Mobility (cellular connections) within a building	5
Mobility within a Geographical area or moving in a vehicle	10
Access to hard-to-reach location; (for example, via multi-hop satellite connections)	20

These values are only suggestions. To be meaningful, the use of the factor *A* and its selected value in a specific application should be used consistently in any planning model you adopt. However, the values in the table above should be considered as the absolute upper limits for *A* .

The default Advantage Factor for IP SLAs VoIP UDP jitter operations is always zero.

The IP SLAs MOS Value

IP SLAs uses an observed correspondence between ICPIF and MOS values to estimate an MOS value. Usage of the abbreviation MOS within the context of this feature should be taken to represent the MOS-CQE (Mean Opinion Score; Conversational Quality, Estimated).

The E model, as defined in G.107 (03/2003), predicts the subjective quality that is experienced by an average listener by combining the impairment caused by transmission parameters (such as loss and delay) into a single rating, the transmission rating factor R (the R Factor). This rating, expressed in a scale of 0 (worst) to 100 (best) can be used to predict subjective user reactions, such as the MOS. Specifically, the MOS can be obtained from the R Factor with a converting formula. Conversely, a modified inverted form can be used to calculate R Factors from MOS values.

There is also a relationship between the ICPIF value and the R Factor. IP SLAs takes advantage of this correspondence by deriving the approximate MOS score from an estimated R Factor, which, in turn, is derived from the ICPIF score. The table below shows the resulting MOS values that will be generated for corresponding ICPIF values.

Table 9: Correspondence of ICPIF Values to MOS Values

ICPIF Range	MOS	Quality Category
0 - 3	5	Best
4 - 13	4	High
14 - 23	3	Medium
24 - 33	2	Low
34 - 43	1	Poor

IP SLAs will always express the estimated MOS value as a number in the range of 1 to 5, with 5 being the best quality. A MOS value of 0 (zero) indicates that MOS data could not be generated for the operation.

How to Configure IP SLAs UDP Jitter Operations for VoIP

Configuring the IP SLAs Responder on a Destination Device

Note A responder should not configure a permanent port for a sender. If the responder configures a permanent port for a sender, even if the packets are successfully sent (no timeout or packet-loss issues), the jitter value is zero.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. Enter one of the following commands:
   - **ip sla responder**
   - **ip sla responder udp-echo ipaddress** *ip-address* **port** *port*
4. **end**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Device> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Device# configure terminal`	Enters global configuration mode.
Step 3	Enter one of the following commands: • **ip sla responder** • **ip sla responder udp-echo ipaddress** *ip-address* **port** *port*	(Optional) Temporarily enables IP SLAs responder functionality on a Cisco device in response to control messages from the source. (Optional; required only if protocol control is disabled on the source.) Enables IP SLAs responder functionality on the specified IP address and port.

	Command or Action	Purpose

	Example:
	`Device(config)# ip sla responder`
	`Device(config)# ip sla responder udp-echo ipaddress 192.0.2.132 port 5000`
		• Protocol control is enabled by default.

Step 4	**end** **Example:** `Device(config)# end`	Exits global configuration mode and returns to privileged EXEC mode.

Configuring and Scheduling an IP SLAs VoIP UDP Jitter Operation

Note

- Currently, IP SLAs supports only the following speech codecs (compression methods):
  - G.711 A Law (g711alaw: 64 kbps PCM compression method)
  - G.711 mu Law (g711ulaw: 64 kbps PCM compression method)
  - G.729A (g729a: 8 kbps CS-ACELP compression method)
- The following commands, available in UDP jitter configuration mode, are not valid for UDP jitter (codec) operations:
  - **history distributions-of-statistics-kept**
  - **history statistics-distribution-interval**
  - **request-data-size**
- Specifying the codec-type will configure the appropriate default values for the **codec-interval**, **codec-size**, and **codec-numpacket** options. You should not specify values for the interval, size, and number of packet options unless you have a specific reason to override the defaults (for example, approximating a different codec).
- The **show ip sla configuration** command will list the values for the "Number of statistic distribution buckets kept" and "Statistic distribution interval (milliseconds)," but these values do not apply to jitter (codec) operations.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **ip sla** *operation-number*
4. **udp-jitter** {*destination-ip-address* | *destination-hostname*} *destination-port* **codec** *codec-type* [**codec-numpackets** *number-of-packets*] [**codec-size** *number-of-bytes*] [**codec-interval** *milliseconds*] [**advantage-factor** *value*] [**source-ip** {*ip-address* | *hostname*}] [**source-port** *port-number*] [**control** {**enable** | **disable**}]
5. **history enhanced** [**interval** *seconds*] [**buckets** *number-of-buckets*]
6. **frequency** *seconds*
7. **history hours-of-statistics-kept** *hours*
8. **owner** *owner-id*
9. **tag** *text*
10. **threshold** *milliseconds*
11. **timeout** *milliseconds*
12. Do one of the following:
    - **tos** *number*
    - **traffic-class** *number*
13. **flow-label** *number*
14. **verify-data**
15. **vrf** *vrf-name*
16. **end**
17. **show ip sla configuration** [*operation-number*]

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Device> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Device# configure terminal`	Enters global configuration mode.

	Command or Action	Purpose
Step 3	**ip sla** *operation-number* **Example:** `Device(config)# ip sla 10`	Begins configuration for an IP SLAs operation and enters IP SLA configuration mode.
Step 4	**udp-jitter** {*destination-ip-address* | *destination-hostname*} *destination-port* **codec** *codec-type* [**codec-numpackets** *number-of-packets*] [**codec-size** *number-of-bytes*] [**codec-interval** *milliseconds*] [**advantage-factor** *value*] [**source-ip** {*ip-address* | *hostname*}] [**source-port** *port-number*] [**control** {**enable** | **disable**}] **Example:** `Device(config-ip-sla)# udp-jitter 209.165.200.225 16384 codec g711alaw advantage-factor 10`	Configures the operation as a jitter (codec) operation that will generate VoIP scores in addition to latency, jitter, and packet loss statistics.
Step 5	**history enhanced** [**interval** *seconds*] [**buckets** *number-of-buckets*] **Example:** `Device(config-ip-sla-jitter)# history enhanced interval 900 buckets 100`	(Optional) Enables enhanced history gathering for an IP SLAs operation.
Step 6	**frequency** *seconds* **Example:** `Device(config-ip-sla-jitter)# frequency 30`	(Optional) Sets the rate at which a specified IP SLAs operation repeats.
Step 7	**history hours-of-statistics-kept** *hours* **Example:** `Device(config-ip-sla-jitter)# history hours-of-statistics-kept 4`	(Optional) Sets the number of hours for which statistics are maintained for an IP SLAs operation.
Step 8	**owner** *owner-id* **Example:** `Device(config-ip-sla-jitter)# owner admin`	(Optional) Configures the Simple Network Management Protocol (SNMP) owner of an IP SLAs operation.
Step 9	**tag** *text* **Example:** `Device(config-ip-sla-jitter)# tag TelnetPollServer1`	(Optional) Creates a user-specified identifier for an IP SLAs operation.

	Command or Action	Purpose
Step 10	**threshold** *milliseconds* **Example:** `Device(config-ip-sla-jitter)# threshold 10000`	(Optional) Sets the upper threshold value for calculating network monitoring statistics created by an IP SLAs operation.
Step 11	**timeout** *milliseconds* **Example:** `Device(config-ip-sla-jitter)# timeout 10000`	(Optional) Sets the amount of time an IP SLAs operation waits for a response from its request packet.

Step 12	Do one of the following:
	• **tos** *number*
	• **traffic-class** *number*
	Example:
	`Device(config-ip-sla-jitter)# tos 160`
	Example:
	`Device(config-ip-sla-jitter)# traffic-class 160`
		(Optional) In an IPv4 network only, defines the ToS byte in the IPv4 header of an IP SLAs operation.
		or
		(Optional) In an IPv6 network only, defines the traffic class byte in the IPv6 header for a supported IP SLAs operation.

Step 13	**flow-label** *number* **Example:** `Device(config-ip-sla-jitter)# flow-label 112233`	(Optional) In an IPv6 network only, defines the flow label field in the IPv6 header for a supported IP SLAs operation.
Step 14	**verify-data** **Example:** `Device(config-ip-sla-jitter)# verify-data`	(Optional) Causes an IP SLAs operation to check each reply packet for data corruption.
Step 15	**vrf** *vrf-name* **Example:** `Device(config-ip-sla-jitter)# vrf vpn-A`	(Optional) Allows monitoring within Multiprotocol Label Switching (MPLS) Virtual Private Networks (VPNs) using IP SLAs operations.
Step 16	**end** **Example:** `Device(config-ip-sla-jitter)# end`	Returns to privileged EXEC mode.

	Command or Action	Purpose
Step 17	**show ip sla configuration** [*operation-number*] **Example:** `Device# show ip sla configuration 10`	(Optional) Displays configuration values including all defaults for all IP SLAs operations or a specified operation.

Scheduling IP SLAs Operations

Before You Begin

- All IP Service Level Agreements (SLAs) operations to be scheduled must be already configured.
- The frequency of all operations scheduled in a multioperation group must be the same.
- The list of one or more operation ID numbers to be added to a multioperation group must be limited to a maximum of 125 characters in length, including commas (,).

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. Enter one of the following commands:
   - **ip sla schedule** *operation-number* [**life** {**forever** | *seconds*}] [**start-time** {[*hh*:*mm*:*ss*] [*month day* | *day month*] | **pending** | **now** | **after** *hh*:*mm*:*ss*}] [**ageout** *seconds*] [**recurring**]
   - **ip sla group schedule** *group-operation-number operation-id-numbers* {**schedule-period** *schedule-period-range* | **schedule-together**} [**ageout** *seconds*] [**frequency** *group-operation-frequency*] [**life** {**forever** | *seconds*}] [**start-time** {*hh*:*mm* [:*ss*] [*month day* | *day month*] | **pending** | **now** | **after** *hh*:*mm* [:*ss*]}]
4. **end**
5. **show ip sla group schedule**
6. **show ip sla configuration**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Device> enable`	Enables privileged EXEC mode. • Enter your password if prompted.

	Command or Action	Purpose
Step 2	**configure terminal** **Example:** `Device# configure terminal`	Enters global configuration mode.

Step 3	Enter one of the following commands:
	• **ip sla schedule** *operation-number* [**life** {**forever** | *seconds*}] [**start-time** {[*hh*:*mm*:*ss*] [*month day* | *day month*] | **pending** | **now** | **after** *hh*:*mm*:*ss*}] [**ageout** *seconds*] [**recurring**]
	• **ip sla group schedule** *group-operation-number operation-id-numbers* {**schedule-period** *schedule-period-range* | **schedule-together**} [**ageout** *seconds*] [**frequency** *group-operation-frequency*] [**life** {**forever** | *seconds*}] [**start-time** {*hh*:*mm* [:*ss*] [*month day* | *day month*] | **pending** | **now** | **after** *hh*:*mm* [:*ss*]}]
	
	Example:
	`Device(config)# ip sla schedule 10 life forever start-time now`
	`Device(config)# ip sla group schedule 10 schedule-period frequency`
	`Device(config)# ip sla group schedule 1 3,4,6-9 life forever start-time now`
	`Device(config)# ip sla schedule 1 3,4,6-9 schedule-period 50 frequency range 80-100`
		• Configures the scheduling parameters for an individual IP SLAs operation.
		• Specifies an IP SLAs operation group number and the range of operation numbers for a multioperation scheduler.

Step 4	**end** **Example:** `Device(config)# end`	Exits global configuration mode and returns to privileged EXEC mode.
Step 5	**show ip sla group schedule** **Example:** `Device# show ip sla group schedule`	(Optional) Displays IP SLAs group schedule details.
Step 6	**show ip sla configuration** **Example:** `Device# show ip sla configuration`	(Optional) Displays IP SLAs configuration details.

Troubleshooting Tips

- If the IP Service Level Agreements (SLAs) operation is not running and not generating statistics, add the **verify-data** command to the configuration (while configuring in IP SLA configuration mode) to enable data verification. When data verification is enabled, each operation response is checked for corruption. Use the **verify-data** command with caution during normal operations because it generates unnecessary overhead.
- Use the **debug ip sla trace** and **debug ip sla error** commands to help troubleshoot issues with an IP SLAs operation.

What to Do Next

To add proactive threshold conditions and reactive triggering for generating traps (or for starting another operation) to an IP Service Level Agreements (SLAs) operation, see the "Configuring Proactive Threshold Monitoring" section.

Configuration Examples for IP SLAs UDP Jitter Operations for VoIP

Example IP SLAs VoIP UDP Operation Configuration

The following example assumes that the Cisco IP SLAs Responder is enabled on the device at 209.165.200.225.

```
Device> enable

Password:
Device# configure terminal

Enter configuration commands, one per line.  End with the end command.
Device(config)# ip sla 10
Device(config-sla)# udp-jitter 209.165.200.225 16384 codec g711alaw advantage-factor 2

Device(config-sla-jitter)# owner admin_bofh
Device(config-sla-jitter)# exit

Device(config)# ip sla schedule 10 start-time now

Device(config)# exit

Device#
Device# show running-config | begin ip sla 10

ip sla 10
 udp-jitter 209.165.200.225 16384 codec g711alaw advantage-factor 2
 owner admin_bofh
ip sla schedule 10 start-time now
 .
 .
 .
Device# show ip sla configuration 10

Entry number: 10
Owner: admin_bofh
```

```
Tag:
Type of operation to perform: jitter
Target address: 209.165.200.225
Source address: 0.0.0.0
Target port: 16384
Source port: 0
Operation timeout (milliseconds): 5000
Codec Type: g711alaw
Codec Number Of Packets: 1000
Codec Packet Size: 172
Codec Interval (milliseconds): 20
Advantage Factor: 2
Type Of Service parameters: 0x0
Verify data: No
Vrf Name:
Control Packets: enabled
Operation frequency (seconds): 60
Next Scheduled Start Time: Start Time already passed
Life (seconds): 3600
Entry Ageout (seconds): never
Status of entry (SNMP RowStatus): Active
Connection loss reaction enabled: No
Timeout reaction enabled: No
Verify error enabled: No
Threshold reaction type: Never
Threshold (milliseconds): 5000
Threshold Falling (milliseconds): 3000
Threshold Count: 5
Threshold Count2: 5
Reaction Type: None
Number of statistic hours kept: 2
Number of statistic distribution buckets kept: 1
Statistic distribution interval (milliseconds): 20
Enhanced History:
```

When a codec type is configured for a jitter operation, the standard jitter "Request size (ARR data portion)," "Number of packets," and "Interval (milliseconds)" parameters will not be displayed in the **show ip sla configuration** command output. Instead, values for "Codec Packet Size," "Codec Number of Packets," and "Codec Interval (milliseconds)" are displayed.

Example IP SLAs VoIP UDP Operation Statistics Output

Use the **show ip sla statistics** command to display Voice scores (ICPIF and MOS values) for the jitter (codec) operation.

```
Device# show ip sla statistics 10

Entry number: 10
Modification time: 12:57:45.690 UTC Sun Oct 26 2003
Number of operations attempted: 1
Number of operations skipped: 0
Current seconds left in Life: Forever
Operational state of entry: Active
Last time this entry was reset: Never
Connection loss occurred: FALSE
Timeout occurred: FALSE
Over thresholds occurred: FALSE
Latest RTT (milliseconds): 19
Latest operation start time: 12:57:45.723 Sun Oct 26 2003
Latest operation return code: OK
!
Voice Scores:
ICPIF:  20          MOS Score:  3.20
!
RTT Values:
NumOfRTT: 10     RTTAvg: 19      RTTMin: 19     RTTMax: 20
RTTSum:  191    RTTSum2: 3649
Packet Loss Values:
```

```
PacketLossSD: 0 PacketLossDS: 0
PacketOutOfSequence: 0  PacketMIA: 0    PacketLateArrival: 0
InternalError: 0        Busies: 0
Jitter Values:
NumOfJitterSamples: 9
MinOfPositivesSD: 0     MaxOfPositivesSD: 0
NumOfPositivesSD: 0     SumOfPositivesSD: 0     Sum2PositivesSD: 0
MinOfNegativesSD: 0     MaxOfNegativesSD: 0
NumOfNegativesSD: 0     SumOfNegativesSD: 0     Sum2NegativesSD: 0
MinOfPositivesDS: 1     MaxOfPositivesDS: 1
NumOfPositivesDS: 1     SumOfPositivesDS: 1     Sum2PositivesDS: 1
MinOfNegativesDS: 1     MaxOfNegativesDS: 1
NumOfNegativesDS: 1     SumOfNegativesDS: 1     Sum2NegativesDS: 1
Interarrival jitterout: 0       Interarrival jitterin: 0
One Way Values:
NumOfOW: 0
OWMinSD: 0      OWMaxSD: 0      OWSumSD: 0      OWSum2SD: 0
OWMinDS: 0      OWMaxDS: 0      OWSumDS: 0      OWSum2DS: 0
```

Additional References

Related Documents

Related Topic	Document Title
Cisco IOS commands	Cisco IOS Master Commands List, All Releases
Cisco IOS IP SLAs commands	Cisco IOS IP SLAs Command Reference
Voice over IP (VoIP) codecs	Understanding Codecs: Complexity, Hardware Support, MOS, and Negotiation
Jitter in Packet Voice Networks	Understanding Jitter in Packet Voice Networks (Cisco IOS Platforms) shtml

Standards and RFCs

Standard[1]/RFC[2]	Title
ITU-T Recommendation G.107 (2003)	The E-model, a computation model for use in transmission planning
ITU-T Recommendation G.113 (1996)	*Transmission impairments*
ITU-T Recommendation G.113 (2001)	Transmission impairments due to speech processing
ITU-T Recommendation G.711 (1998)	*Pulse code modulation (PCM) of voice frequencies* (also known as the G.711 Voice Codec)
ITU-T Recommendation G.729 Annex A (1996)	*Reduced complexity 8 kbit/s CS-ACELP speech codec* (also known as the G.729/A/B Speech Codec)
ITU-T Recommendation P.800.1 (2003)	Mean Opinion Score (MOS) terminology

Standard[1]/RFC[2]	Title
RFC 768	*User Datagram Protocol*
RFC 1889	*RTP: A Transport Protocol for Real-Time Applications*

1 Full support by this feature for listed RFCs is not claimed. ITU Telecommunication Standards ("ITU-T Recommendations In Force") can be obtained from http://www.itu.ch. Summary definitions are available from a variety of internet sources.
2 Full support by this feature for listed RFCs is not claimed.

MIBs

MIB	MIB Link
CISCO-RTTMON-MIB	To locate and download MIBs for selected platforms, Cisco IOS releases, and feature sets, use Cisco MIB Locator found at the following URL: http://www.cisco.com/go/mibs

Technical Assistance

Description	Link
The Cisco Support and Documentation website provides online resources to download documentation, software, and tools. Use these resources to install and configure the software and to troubleshoot and resolve technical issues with Cisco products and technologies. Access to most tools on the Cisco Support and Documentation website requires a Cisco.com user ID and password.	http://www.cisco.com/cisco/web/support/index.html

Feature Information for IP SLAs VoIP UDP Jitter Operations

The following table provides release information about the feature or features described in this module. This table lists only the software release that introduced support for a given feature in a given software release train. Unless noted otherwise, subsequent releases of that software release train also support that feature.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to . An account on Cisco.com is not required.

Table 10: Feature Information for the IP SLAs VoIP UDP Jitter Operation

Feature Name	Releases	Feature Information
IP SLAs - UDP Based VoIP Operation	Cisco IOS XE Release 3.2SE	The IP SLAs User Datagram Protocol (UDP) jitter operation allows you to measure round-trip delay, one-way delay, one-way jitter, one-way packet loss, and connectivity in networks that carry UDP traffic. In Cisco IOS XE Release 3.2SE, this feature was supported on the following platforms: • Catalyst 3650 Series Switches • Catalyst 3850 Series Switches • Cisco 5760 Wireless LAN Controller
IP SLAs for IPv6 (UDP Jitter, UDP Echo, ICMP Echo, TCP Connect)	Cisco IOS XE Release 3.2SE	Support was added for operability in IPv6 networks. In Cisco IOS XE Release 3.2SE, this feature was supported on the following platforms: • Catalyst 3650 Series Switches • Catalyst 3850 Series Switches • Cisco 5760 Wireless LAN Controller

Glossary

codec --In the context of IP Telephony, a codec is a compression and decompression algorithm used to transfer voice and video data more efficiently. Voice codec types are typically referred to using the ITU recommendation number that defines the algorithm (for example, “G.711” instead of “PCM”).

CS-ACELP --The codec type defined in the reference documents G.729 and G.729A, *Coding of speech at 8 kbit/s using conjugate-structure algebraic-code-excited linear-prediction (CS-ACELP)* .

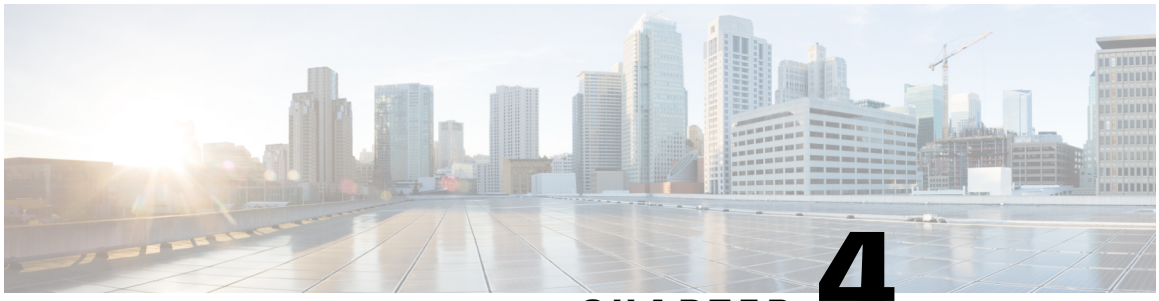
ITU --The International Telecommunication Union. The ITU is an international organization within the United Nations System where governments and the private sector coordinate global telecom networks and services. The ITU Telecommunication Standardization Sector (ITU-T), responsible for defining standards (Recommendations) covering all fields of telecommunications, is one of the three operational sectors of the ITU. The ITU web site is at http://www.itu.int.

ITU-T --ITU Telecommunication Standardization Sector. The ITU-T is one of the three operational sectors of the ITU, and is responsible for defining standards (called ITU-T Recommendations) covering all fields of telecommunications.

MOS-CQE (Mean Opinion Score; Conversational Quality, Estimated)--The score calculated by a network planning model which aims at predicting the quality in a conversational application situation. Estimates of conversational quality carried out according to ITU-T Rec. G.107, when transformed to a mean opinion score (MOS), give results in terms of MOS-CQE.[3]

PCM --The codec type defined in the reference document G.711, *Pulse code modulation (PCM) of voice frequencies* .

3 Definition from ITU-T Recommendation P.800.1. Used in accordance with the ITU Copyright and Disclaimer Notice.



CHAPTER 4

Configuring IP SLAs UDP Echo Operations

This module describes how to configure an IP Service Level Agreements (SLAs) User Datagram Protocol (UDP) Echo operation to monitor end-to-end response time between a Cisco device and devices using IPv4 or IPv6. UDP echo accuracy is enhanced by using the Cisco IP SLAs Responder at the destination Cisco device. This module also demonstrates how the results of the UDP echo operation can be displayed and analyzed to determine how a UDP application is performing.

Finding Feature Information

Your software release may not support all the features documented in this module. For the latest caveats and feature information, see Bug Search Tool and the release notes for your platform and software release. To find information about the features documented in this module, and to see a list of the releases in which each feature is supported, see the feature information table.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to www.cisco.com/go/cfn. An account on Cisco.com is not required.

Restrictions for IP SLAs UDP Echo Operations

We recommend using a Cisco networking device as the destination device, although any networking device that supports RFC 862, *Echo Protocol* , can be used.

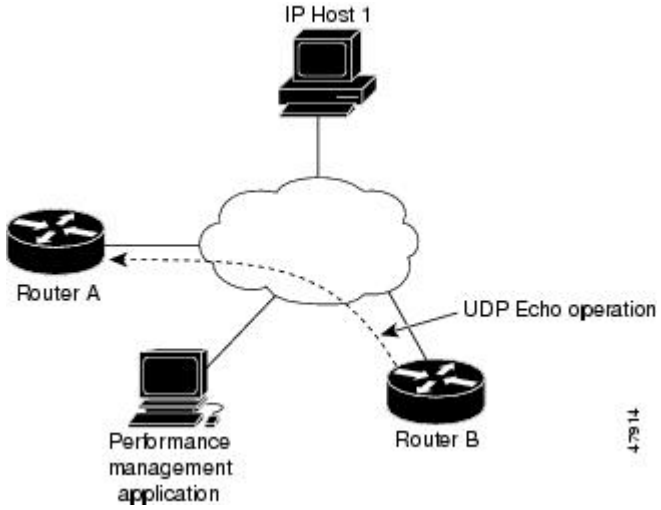
Information About IP SLAs UDP Echo Operations

UDP Echo Operation

The UDP echo operation measures end-to-end response time between a Cisco device and devices using IP. UDP is a transport layer (Layer 4) Internet protocol that is used for many IP services. UDP echo is used to measure response times and test end-to-end connectivity.

In the figure below Device A has been configured as an IP SLAs Responder and Device B is configured as the source IP SLAs device.

Figure 4: UDP Echo Operation



Response time (round-trip time) is computed by measuring the time taken between sending a UDP echo request message from Device B to the destination device--Device A--and receiving a UDP echo reply from Device A. UDP echo accuracy is enhanced by using the IP SLAs Responder at Device A, the destination Cisco device. If the destination device is a Cisco device, then IP SLAs sends a UDP datagram to any port number that you specified. Using the IP SLAs Responder is optional for a UDP echo operation when using Cisco devices. The IP SLAs Responder cannot be configured on non-Cisco devices.

The results of a UDP echo operation can be useful in troubleshooting issues with business-critical applications by determining the round-trip delay times and testing connectivity to both Cisco and non-Cisco devices.

How to Configure IP SLAs UDP Echo Operations

Configuring the IP SLAs Responder on a Destination Device

Note A responder should not configure a permanent port for a sender. If the responder configures a permanent port for a sender, even if the packets are successfully sent (no timeout or packet-loss issues), the jitter value is zero.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. Enter one of the following commands:
   - **ip sla responder**
   - **ip sla responder udp-echo ipaddress** *ip-address* **port** *port*
4. **end**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Device> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Device# configure terminal`	Enters global configuration mode.
Step 3	Enter one of the following commands: • **ip sla responder** • **ip sla responder udp-echo ipaddress** *ip-address* **port** *port*	(Optional) Temporarily enables IP SLAs responder functionality on a Cisco device in response to control messages from the source. (Optional; required only if protocol control is disabled on the source.) Enables IP SLAs responder functionality on the specified IP address and port.

	Command or Action	Purpose

	Example:
	`Device(config)# ip sla responder`
	`Device(config)# ip sla responder udp-echo ipaddress 192.0.2.132 port 5000`
		• Protocol control is enabled by default.

Step 4	**end** **Example:** `Device(config)# end`	Exits global configuration mode and returns to privileged EXEC mode.

Configuring a UDP Echo Operation on the Source Device

Perform only one of the following tasks:

Configuring a Basic UDP Echo Operation on the Source Device

Before You Begin

If you are using the IP SLAs Responder, ensure that you have completed the "Configuring the IP SLAs Responder on the Destination Device" section before you start this task.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **ip sla** *operation-number*
4. **udp-echo** {*destination-ip-address* | *destination-hostname*} *destination-port* [**source-ip** {*ip-address* | *hostname*} **source-port** *port-number*] [**control** {**enable** | **disable**}]
5. **frequency** *seconds*
6. **end**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Device> enable`	Enables privileged EXEC mode. • Enter your password if prompted.

	Command or Action	Purpose
Step 2	**configure terminal** **Example:** `Device# configure terminal`	Enters global configuration mode.
Step 3	**ip sla** *operation-number* **Example:** `Device(config)# ip sla 10`	Begins configuration for an IP SLAs operation and enters IP SLA configuration mode.
Step 4	**udp-echo** {*destination-ip-address* | *destination-hostname*} *destination-port* [**source-ip** {*ip-address* | *hostname*} **source-port** *port-number*] [**control** {**enable** | **disable**}] **Example:** `Device(config-ip-sla)# udp-echo 172.29.139.134 5000`	Defines a UDP echo operation and enters IP SLA UDP configuration mode. • Use the **control disable** keyword combination only if you disable the IP SLAs control protocol on both the source and target devices.
Step 5	**frequency** *seconds* **Example:** `Device(config-ip-sla-udp)# frequency 30`	(Optional) Sets the rate at which a specified IP SLAs operation repeats.
Step 6	**end** **Example:** `Device(config-ip-sla-udp)# end`	Returns to prileged EXEC mode.

What to Do Next

To add proactive threshold conditions and reactive triggering for generating traps, or for starting another operation, to an IP SLAs operation, see the "Configuring Proactive Threshold Monitoring" section.

Configuring a UDP Echo Operation with Optional Parameters on the Source Device

Before You Begin

If you are using an IP SLAs Responder in this operation, the responder must be configured on the destination device. See the "Configuring the IP SLAs Responder on the Destination Device."

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **ip sla** *operation-number*
4. **udp-echo** {*destination-ip-address* | *destination-hostname*} *destination-port* [**source-ip** {*ip-address* | *hostname*} **source-port** *port-number*] [**control** {**enable** | **disable**}]
5. **history buckets-kept** *size*
6. **data-pattern** *hex-pattern*
7. **history distributions-of-statistics-kept** *size*
8. **history enhanced** [**interval** *seconds*] [**buckets** *number-of-buckets*]
9. **history filter** {**none** | **all** | **overThreshold** | **failures**}
10. **frequency** *seconds*
11. **history hours-of-statistics-kept** *hours*
12. **history lives-kept** *lives*
13. **owner** *owner-id*
14. **request-data-size** *bytes*
15. **history statistics-distribution-interval** *milliseconds*
16. **tag** *text*
17. **threshold** *milliseconds*
18. **timeout** *milliseconds*
19. Do one of the following:
    - **tos** *number*
    - **traffic-class** *number*
20. **flow-label** *number*
21. **verify-data**
22. **exit**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Device> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Device# configure terminal`	Enters global configuration mode.

	Command or Action	Purpose
Step 3	**ip sla** *operation-number* **Example:** `Device(config)# ip sla 10`	Begins configuration for an IP SLAs operation and enters IP SLA configuration mode.
Step 4	**udp-echo** {*destination-ip-address* | *destination-hostname*} *destination-port* [**source-ip** {*ip-address* | *hostname*} **source-port** *port-number*] [**control** {**enable** | **disable**}] **Example:** `Device(config-ip-sla)# udp-echo 172.29.139.134 5000`	Defines a UDP echo operation and enters IP SLA UDP configuration mode. • Use the **control disable** keyword combination only if you disable the IP SLAs control protocol on both the source and target devices.
Step 5	**history buckets-kept** *size* **Example:** `Device(config-ip-sla-udp)# history buckets-kept 25`	(Optional) Sets the number of history buckets that are kept during the lifetime of an IP SLAs operation.
Step 6	**data-pattern** *hex-pattern* **Example:** `Device(config-ip-sla-udp)# data-pattern`	(Optional) Specifies the data pattern in an IP SLAs operation to test for data corruption.
Step 7	**history distributions-of-statistics-kept** *size* **Example:** `Device(config-ip-sla-udp)# history distributions-of-statistics-kept 5`	(Optional) Sets the number of statistics distributions kept per hop during an IP SLAs operation.
Step 8	**history enhanced** [**interval** *seconds*] [**buckets** *number-of-buckets*] **Example:** `Device(config-ip-sla-udp)# history enhanced interval 900 buckets 100`	(Optional) Enables enhanced history gathering for an IP SLAs operation.
Step 9	**history filter** {**none** | **all** | **overThreshold** | **failures**} **Example:** `Device(config-ip-sla-udp)# history filter failures`	(Optional) Defines the type of information kept in the history table for an IP SLAs operation.

	Command or Action	Purpose
Step 10	**frequency** *seconds* **Example:** `Device(config-ip-sla-udp)# frequency 30`	(Optional) Sets the rate at which a specified IP SLAs operation repeats.
Step 11	**history hours-of-statistics-kept** *hours* **Example:** `Device(config-ip-sla-udp)# history hours-of-statistics-kept 4`	(Optional) Sets the number of hours for which statistics are maintained for an IP SLAs operation.
Step 12	**history lives-kept** *lives* **Example:** `Device(config-ip-sla-udp)# history lives-kept 2`	(Optional) Sets the number of lives maintained in the history table for an IP SLAs operation.
Step 13	**owner** *owner-id* **Example:** `Device(config-ip-sla-udp)# owner admin`	(Optional) Configures the Simple Network Management Protocol (SNMP) owner of an IP SLAs operation.
Step 14	**request-data-size** *bytes* **Example:** `Device(config-ip-sla-udp)# request-data-size 64`	(Optional) Sets the protocol data size in the payload of an IP SLAs operation's request packet.
Step 15	**history statistics-distribution-interval** *milliseconds* **Example:** `Device(config-ip-sla-udp)# history statistics-distribution-interval 10`	(Optional) Sets the time interval for each statistics distribution kept for an IP SLAs operation.
Step 16	**tag** *text* **Example:** `Device(config-ip-sla-udp)# tag TelnetPollServer1`	(Optional) Creates a user-specified identifier for an IP SLAs operation.
Step 17	**threshold** *milliseconds* **Example:** `Device(config-ip-sla-udp)# threshold 10000`	(Optional) Sets the upper threshold value for calculating network monitoring statistics created by an IP SLAs operation.

	Command or Action	Purpose
Step 18	**timeout** *milliseconds* **Example:** `Device(config-ip-sla-udp)# timeout 10000`	(Optional) Sets the amount of time an IP SLAs operation waits for a response from its request packet.

Step 19	Do one of the following:
	• **tos** *number*
	• **traffic-class** *number*
	Example:
	`Device(config-ip-sla-jitter)# tos 160`
	Example:
	`Device(config-ip-sla-jitter)# traffic-class 160`
		(Optional) In an IPv4 network only, defines the ToS byte in the IPv4 header of an IP SLAs operation.
		or
		(Optional) In an IPv6 network only, defines the traffic class byte in the IPv6 header for a supported IP SLAs operation.

Step 20	**flow-label** *number* **Example:** `Device(config-ip-sla-udp)# flow-label 112233`	(Optional) In an IPv6 network only, defines the flow label field in the IPv6 header for a supported IP SLAs operation.
Step 21	**verify-data** **Example:** `Device(config-ip-sla-udp)# verify-data`	(Optional) Causes an IP SLAs operation to check each reply packet for data corruption.
Step 22	**exit** **Example:** `Device(config-ip-sla-udp)# exit`	Exits UDP configuration submode and returns to global configuration mode.

What to Do Next

To add proactive threshold conditions and reactive triggering for generating traps, or for starting another operation, to an IP SLAs operation, see the "Configuring Proactive Threshold Monitoring" section.

Scheduling IP SLAs Operations

Before You Begin

- All IP Service Level Agreements (SLAs) operations to be scheduled must be already configured.
- The frequency of all operations scheduled in a multioperation group must be the same.
- The list of one or more operation ID numbers to be added to a multioperation group must be limited to a maximum of 125 characters in length, including commas (,).

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. Enter one of the following commands:
   - **ip sla schedule** *operation-number* [**life** {**forever** | *seconds*}] [**start-time** {[*hh*:*mm*:*ss*] [*month day* | *day month*] | **pending** | **now** | **after** *hh*:*mm*:*ss*}] [**ageout** *seconds*] [**recurring**]
   - **ip sla group schedule** *group-operation-number operation-id-numbers* {**schedule-period** *schedule-period-range* | **schedule-together**} [**ageout** *seconds*] [**frequency** *group-operation-frequency*] [**life** {**forever** | *seconds*}] [**start-time** {*hh*:*mm* [:*ss*] [*month day* | *day month*] | **pending** | **now** | **after** *hh*:*mm* [:*ss*]}]
4. **end**
5. **show ip sla group schedule**
6. **show ip sla configuration**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Device> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Device# configure terminal`	Enters global configuration mode.
Step 3	Enter one of the following commands: • **ip sla schedule** *operation-number* [**life** {**forever**	*seconds*}] [**start-time** {[*hh*:*mm*:*ss*] [*month day*	*day month*]	**pending**	**now**	**after** *hh*:*mm*:*ss*}] [**ageout** *seconds*] [**recurring**]	• Configures the scheduling parameters for an individual IP SLAs operation. • Specifies an IP SLAs operation group number and the range of operation numbers for a multioperation scheduler.

	Command or Action	Purpose

	• **ip sla group schedule** *group-operation-number operation-id-numbers* {**schedule-period** *schedule-period-range* | **schedule-together**} [**ageout** *seconds*] [**frequency** *group-operation-frequency*] [**life** {**forever** | *seconds*}] [**start-time** {*hh*:*mm* [:*ss*] [*month day* | *day month*] | **pending** | **now** | **after** *hh*:*mm* [:*ss*]}]
	
	Example:
	`Device(config)# ip sla schedule 10 life forever start-time now`
	`Device(config)# ip sla group schedule 10 schedule-period frequency`
	`Device(config)# ip sla group schedule 1 3,4,6-9 life forever start-time now`
	`Device(config)# ip sla schedule 1 3,4,6-9 schedule-period 50 frequency range 80-100`	

Step 4	**end** **Example:** `Device(config)# end`	Exits global configuration mode and returns to privileged EXEC mode.
Step 5	**show ip sla group schedule** **Example:** `Device# show ip sla group schedule`	(Optional) Displays IP SLAs group schedule details.
Step 6	**show ip sla configuration** **Example:** `Device# show ip sla configuration`	(Optional) Displays IP SLAs configuration details.

Troubleshooting Tips

- If the IP Service Level Agreements (SLAs) operation is not running and not generating statistics, add the **verify-data** command to the configuration (while configuring in IP SLA configuration mode) to enable data verification. When data verification is enabled, each operation response is checked for corruption. Use the **verify-data** command with caution during normal operations because it generates unnecessary overhead.

- Use the **debug ip sla trace** and **debug ip sla error** commands to help troubleshoot issues with an IP SLAs operation.

What to Do Next

To add proactive threshold conditions and reactive triggering for generating traps (or for starting another operation) to an IP Service Level Agreements (SLAs) operation, see the "Configuring Proactive Threshold Monitoring" section.

Configuration Examples for IP SLAs UDP Echo Operations

Example Configuring a UDP Echo Operation

The following example configures an IP SLAs operation type of UDP echo that will start immediately and run indefinitely.

```
ip sla 5
 udp-echo 172.29.139.134 5000
 frequency 30
 request-data-size 160
 tos 128
 timeout 1000
 tag FLL-RO
ip sla schedule 5 life forever start-time now
```

Additional References

Related Documents

Related Topic	Document Title
Cisco IOS commands	Cisco IOS Master Commands List, All Releases
Cisco IOS IP SLAs commands	Cisco IOS IP SLAs Command Reference

Standards and RFCs

Standard/RFC	Title
RFC 862	Echo Protocol

MIBs

MIBs	MIBs Link
CISCO-RTTMON-MIB	To locate and download MIBs for selected platforms, Cisco IOS releases, and feature sets, use Cisco MIB Locator found at the following URL: http://www.cisco.com/go/mibs

Technical Assistance

Description	Link
The Cisco Support and Documentation website provides online resources to download documentation, software, and tools. Use these resources to install and configure the software and to troubleshoot and resolve technical issues with Cisco products and technologies. Access to most tools on the Cisco Support and Documentation website requires a Cisco.com user ID and password.	http://www.cisco.com/cisco/web/support/index.html

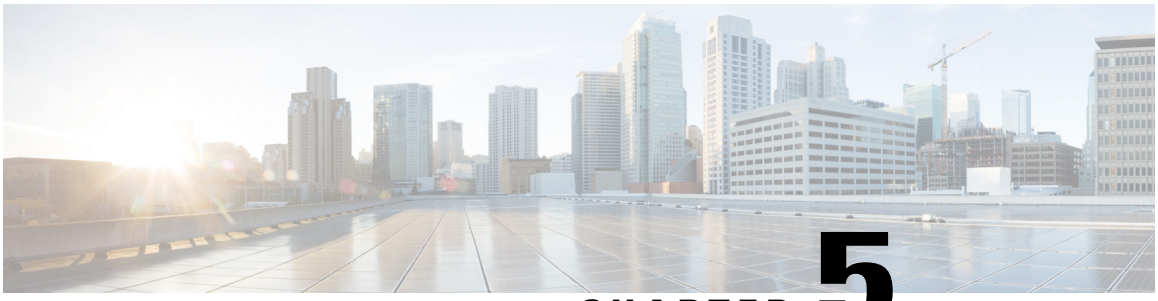
Feature Information for the IP SLAs UDP Echo Operation

The following table provides release information about the feature or features described in this module. This table lists only the software release that introduced support for a given feature in a given software release train. Unless noted otherwise, subsequent releases of that software release train also support that feature.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to . An account on Cisco.com is not required.

Table 11: Feature Information for the IP SLAs UDP Echo Operation

Feature Name	Releases	Feature Information
IP SLAs - UDP Echo Operation	Cisco IOS XE Release 3.2SE	The Cisco IOS IP SLAs User Datagram Protocol (UDP) jitter operation allows you to measure round-trip delay, one-way delay, one-way jitter, one-way packet loss, and connectivity in networks that carry UDP traffic. In Cisco IOS XE Release 3.2SE, this feature was supported on the following platforms: • Catalyst 3650 Series Switches • Catalyst 3850 Series Switches • Cisco 5760 Wireless LAN Controller
IPv6 - IP SLAs (UDP Jitter, UDP Echo, ICMP Echo, TCP Connect)	Cisco IOS XE Release 3.2SE	Support was added for operability in IPv6 networks. In Cisco IOS XE Release 3.2SE, this feature was supported on the following platforms: • Catalyst 3650 Series Switches • Catalyst 3850 Series Switches • Cisco 5760 Wireless LAN Controller



CHAPTER 5

Configuring IP SLAs HTTP Operations

This module describes how to configure an IP Service Level Agreements (SLAs) HTTP operation to monitor the response time between a Cisco device and an HTTP server to retrieve a web page. The IP SLAs HTTP operation supports both the normal GET requests and customer RAW requests. This module also demonstrates how the results of the HTTP operation can be displayed and analyzed to determine how an HTTP server is performing.

Finding Feature Information

Your software release may not support all the features documented in this module. For the latest caveats and feature information, see Bug Search Tool and the release notes for your platform and software release. To find information about the features documented in this module, and to see a list of the releases in which each feature is supported, see the feature information table.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to www.cisco.com/go/cfn. An account on Cisco.com is not required.

Restrictions for IP SLAs HTTP Operations

- IP SLAs HTTP operations support only HTTP/1.0.
- HTTP/1.1 is not supported for any IP SLAs HTTP operation, including HTTP RAW requests.

Information About IP SLAs HTTP Operations

HTTP Operation

The HTTP operation measures the round-trip time (RTT) between a Cisco device and an HTTP server to retrieve a web page. The HTTP server response time measurements consist of three types:

- DNS lookup--RTT taken to perform domain name lookup.
- TCP Connect--RTT taken to perform a TCP connection to the HTTP server.
- HTTP transaction time--RTT taken to send a request and get a response from the HTTP server. The operation retrieves only the home HTML page.

The DNS operation is performed first and the DNS RTT is measured. Once the domain name is found, a TCP Connect operation to the appropriate HTTP server is performed and the RTT for this operation is measured. The final operation is an HTTP request and the RTT to retrieve the home HTML page from the HTTP server is measured. One other measurement is made and called the time to first byte which measures the time from the start of the TCP Connect operation to the first HTML byte retrieved by the HTTP operation. The total HTTP RTT is a sum of the DNS RTT, the TCP Connect RTT, and the HTTP RTT.

For GET requests, IP SLAs will format the request based on the specified URL. For RAW requests, IP SLAs requires the entire content of the HTTP request. When a RAW request is configured, the raw commands are specified in HTTP RAW configuration mode. A RAW request is flexible and allows you to control fields such as authentication. An HTTP request can be made through a proxy server.

The results of an HTTP operation can be useful in monitoring your web server performance levels by determining the RTT taken to retrieve a web page.

How to Configure IP SLAs HTTP Operations

Configuring an HTTP GET Operation on the Source Device

Note This operation does not require an IP SLAs Responder on the destination device.

Perform only one of the following tasks:

Configuring a Basic HTTP GET Operation on the Source Device

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **ip sla** *operation-number*
4. **http** {**get** | **raw**} *url* [**name-server** *ip-address*] [**version** *version-number*] [**source-ip** {*ip-address* | *hostname*}] [**source-port** *port-number*] [**cache** {**enable** | **disable**}] [**proxy** *proxy-url*]
5. **frequency** *seconds*
6. **end**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Device> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Device# configure terminal`	Enters global configuration mode.
Step 3	**ip sla** *operation-number* **Example:** `Device(config)# ip sla 10`	Begins configuration for an IP SLAs operation and enters IP SLA configuration mode.
Step 4	**http** {**get** | **raw**} *url* [**name-server** *ip-address*] [**version** *version-number*] [**source-ip** {*ip-address* | *hostname*}] [**source-port** *port-number*] [**cache** {**enable** | **disable**}] [**proxy** *proxy-url*] **Example:** `Device(config-ip-sla)# http get http://198.133.219.25`	Defines an HTTP operation and enters IP SLA configuration mode.
Step 5	**frequency** *seconds* **Example:** `Device(config-ip-sla-http)# frequency 90`	(Optional) Sets the rate at which a specified IP SLAs HTTP operation repeats. The default and minimum frequency value for an IP SLAs HTTP operation is 60 seconds.

	Command or Action	Purpose
Step 6	**end** **Example:** `Device(config-ip-sla-http)# end`	Exits to privileged EXEC mode.

Configuring an HTTP GET Operation with Optional Parameters on the Source Device

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **ip sla** *operation-number*
4. **http** {**get** | **raw**} *url* [**name-server** *ip-address*] [**version** *version-number*] [**source-ip** {*ip-address* | *hostname*}] [**source-port** *port-number*] [**cache** {**enable** | **disable**}] [**proxy** *proxy-url*]
5. **history buckets-kept** *size*
6. **history distributions-of-statistics-kept** *size*
7. **history enhanced** [**interval** *seconds*] [**buckets** *number-of-buckets*]
8. **history filter** {**none** | **all** | **overThreshold** | **failures**}
9. **frequency** *seconds*
10. **history hours-of-statistics-kept** *hours*
11. **http-raw-request**
12. **history lives-kept** *lives*
13. **owner** *owner-id*
14. **history statistics-distribution-interval** *milliseconds*
15. **tag** *text*
16. **threshold** *milliseconds*
17. **timeout** *milliseconds*
18. **tos** *number*
19. **end**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Device> enable`	Enables privileged EXEC mode. • Enter your password if prompted.

	Command or Action	Purpose
Step 2	**configure terminal** **Example:** `Device# configure terminal`	Enters global configuration mode.
Step 3	**ip sla** *operation-number* **Example:** `Device(config)# ip sla 10`	Begins configuration for an IP SLAs operation and enters IP SLA configuration mode.
Step 4	**http** {**get** | **raw**} *url* [**name-server** *ip-address*] [**version** *version-number*] [**source-ip** {*ip-address* | *hostname*}] [**source-port** *port-number*] [**cache** {**enable** | **disable**}] [**proxy** *proxy-url*] **Example:** `Device(config-ip-sla)# http get http://198.133.219.25`	Defines an HTTP operation and enters IP SLA configuration mode.
Step 5	**history buckets-kept** *size* **Example:** `Device(config-ip-sla-http)# history buckets-kept 25`	(Optional) Sets the number of history buckets that are kept during the lifetime of an IP SLAs operation.
Step 6	**history distributions-of-statistics-kept** *size* **Example:** `Device(config-ip-sla-http)# history distributions-of-statistics-kept 5`	(Optional) Sets the number of statistics distributions kept per hop during an IP SLAs operation.
Step 7	**history enhanced** [**interval** *seconds*] [**buckets** *number-of-buckets*] **Example:** `Device(config-ip-sla-http)# history enhanced interval 900 buckets 100`	(Optional) Enables enhanced history gathering for an IP SLAs operation.
Step 8	**history filter** {**none** | **all** | **overThreshold** | **failures**} **Example:** `Device(config-ip-sla-http)# history filter failures`	(Optional) Defines the type of information kept in the history table for an IP SLAs operation.

	Command or Action	Purpose
Step 9	**frequency** *seconds* **Example:** `Device(config-ip-sla-http)# frequency 90`	(Optional) Sets the rate at which a specified IP SLAs HTTP operation repeats. The default and minimum frequency value for an IP SLAs HTTP operation is 60 seconds.
Step 10	**history hours-of-statistics-kept** *hours* **Example:** `Device(config-ip-sla-http)# history hours-of-statistics-kept 4`	(Optional) Sets the number of hours for which statistics are maintained for an IP SLAs operation.
Step 11	**http-raw-request** **Example:** `Device(config-ip-sla-http)# http-raw-request`	(Optional) Explicitly specifies the options for a GET request for an IP SLAs HTTP operation.
Step 12	**history lives-kept** *lives* **Example:** `Device(config-ip-sla-http)# history lives-kept 5`	(Optional) Sets the number of lives maintained in the history table for an IP SLAs operation.
Step 13	**owner** *owner-id* **Example:** `Device(config-ip-sla-http)# owner admin`	(Optional) Configures the Simple Network Management Protocol (SNMP) owner of an IP SLAs operation.
Step 14	**history statistics-distribution-interval** *milliseconds* **Example:** `Device(config-ip-sla-http)# history statistics-distribution-interval 10`	(Optional) Sets the time interval for each statistics distribution kept for an IP SLAs operation.
Step 15	**tag** *text* **Example:** `Device(config-ip-sla-http)# tag TelnetPollServer1`	(Optional) Creates a user-specified identifier for an IP SLAs operation.
Step 16	**threshold** *milliseconds* **Example:** `Device(config-ip-sla-http)# threshold 10000`	(Optional) Sets the upper threshold value for calculating network monitoring statistics created by an IP SLAs operation.

	Command or Action	Purpose
Step 17	**timeout** *milliseconds* **Example:** `Device(config-ip-sla-http)# timeout 10000`	(Optional) Sets the amount of time an IP SLAs operation waits for a response from its request packet.
Step 18	**tos** *number* **Example:** `Device(config-ip-sla-http)# tos 160`	(Optional) Defines a type of service (ToS) byte in the IP header of an IP SLAs operation.
Step 19	**end** **Example:** `Device(config-ip-sla-http)# end`	Exits to privileged EXEC mode.

Configuring an HTTP RAW Operation on the Source Device

Note This operation does not require an IP SLAs Responder on the destination device.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **ip sla** *operation-number*
4. **http** {**get** | **raw**} *url* [**name-server** *ip-address*] [**version** *version-number*] [**source-ip** {*ip-address* | *hostname*}] [**source-port** *port-number*] [**cache** {**enable** | **disable**}] [**proxy** *proxy-url*]
5. **http-raw-request**
6. Enter the required HTTP 1.0 command syntax.
7. **end**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable**	Enables privileged EXEC mode.

	Command or Action	Purpose
	Example: `Device> enable`	• Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Device# configure terminal`	Enters global configuration mode.
Step 3	**ip sla** *operation-number* **Example:** `Device(config)# ip sla 10`	Begins configuration for an IP SLAs operation and enters IP SLA configuration mode.
Step 4	**http** {**get** | **raw**} *url* [**name-server** *ip-address*] [**version** *version-number*] [**source-ip** {*ip-address* | *hostname*}] [**source-port** *port-number*] [**cache** {**enable** | **disable**}] [**proxy** *proxy-url*] **Example:** `Device(config-ip-sla)# http raw http://198.133.219.25`	Defines an HTTP operation.
Step 5	**http-raw-request** **Example:** `Device(config-ip-sla)# http-raw-request`	Enters HTTP RAW configuration mode.
Step 6	Enter the required HTTP 1.0 command syntax. **Example:** `Device(config-ip-sla-http)# GET /en/US/hmpgs/index.html HTTP/1.0\r\n\r\n`	Specifies all the required HTTP 1.0 commands.
Step 7	**end** **Example:** `Device(config-ip-sla-http)# end`	Exits to privileged EXEC mode.

Scheduling IP SLAs Operations

Before You Begin

- All IP Service Level Agreements (SLAs) operations to be scheduled must be already configured.
- The frequency of all operations scheduled in a multioperation group must be the same.
- The list of one or more operation ID numbers to be added to a multioperation group must be limited to a maximum of 125 characters in length, including commas (,).

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. Enter one of the following commands:
   - **ip sla schedule** *operation-number* [**life** {**forever** | *seconds*}] [**start-time** {[*hh*:*mm*:*ss*] [*month day* | *day month*] | **pending** | **now** | **after** *hh*:*mm*:*ss*}] [**ageout** *seconds*] [**recurring**]
   - **ip sla group schedule** *group-operation-number operation-id-numbers* {**schedule-period** *schedule-period-range* | **schedule-together**} [**ageout** *seconds*] [**frequency** *group-operation-frequency*] [**life** {**forever** | *seconds*}] [**start-time** {*hh*:*mm* [:*ss*] [*month day* | *day month*] | **pending** | **now** | **after** *hh*:*mm* [:*ss*]}]
4. **end**
5. **show ip sla group schedule**
6. **show ip sla configuration**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Device> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Device# configure terminal`	Enters global configuration mode.
Step 3	Enter one of the following commands: • **ip sla schedule** *operation-number* [**life** {**forever**	*seconds*}] [**start-time** {[*hh*:*mm*:*ss*] [*month day*	*day month*]	**pending**	**now**	**after** *hh*:*mm*:*ss*}] [**ageout** *seconds*] [**recurring**]	• Configures the scheduling parameters for an individual IP SLAs operation. • Specifies an IP SLAs operation group number and the range of operation numbers for a multioperation scheduler.

	Command or Action	Purpose
	• **ip sla group schedule** *group-operation-number operation-id-numbers* {**schedule-period** *schedule-period-range* | **schedule-together**} [**ageout** *seconds*] [**frequency** *group-operation-frequency*] [**life** {**forever** | *seconds*}] [**start-time** {*hh*:*mm* [:*ss*] [*month day* | *day month*] | **pending** | **now** | **after** *hh*:*mm* [:*ss*]}]	

	Example:
	`Device(config)# ip sla schedule 10 life forever start-time now`
	`Device(config)# ip sla group schedule 10 schedule-period frequency`
	`Device(config)# ip sla group schedule 1 3,4,6-9 life forever start-time now`
	`Device(config)# ip sla schedule 1 3,4,6-9 schedule-period 50 frequency range 80-100`	

Step 4	**end** **Example:** `Device(config)# end`	Exits global configuration mode and returns to privileged EXEC mode.
Step 5	**show ip sla group schedule** **Example:** `Device# show ip sla group schedule`	(Optional) Displays IP SLAs group schedule details.
Step 6	**show ip sla configuration** **Example:** `Device# show ip sla configuration`	(Optional) Displays IP SLAs configuration details.

Troubleshooting Tips

- If the IP Service Level Agreements (SLAs) operation is not running and not generating statistics, add the **verify-data** command to the configuration (while configuring in IP SLA configuration mode) to enable data verification. When data verification is enabled, each operation response is checked for corruption. Use the **verify-data** command with caution during normal operations because it generates unnecessary overhead.

- Use the **debug ip sla trace** and **debug ip sla error** commands to help troubleshoot issues with an IP SLAs operation.

What to Do Next

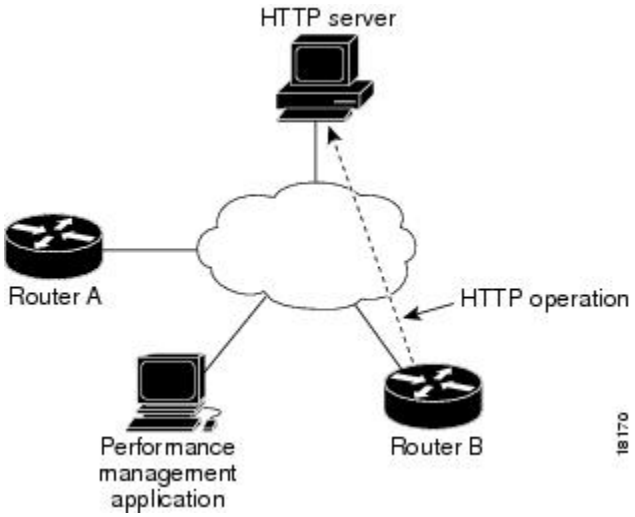
To add proactive threshold conditions and reactive triggering for generating traps (or for starting another operation) to an IP Service Level Agreements (SLAs) operation, see the "Configuring Proactive Threshold Monitoring" section.

Configuration Examples for IP SLAs HTTP Operations

Example Configuring an HTTP GET Operation

The following example show how to create and configure operation number 8 as an HTTP GET operation. The destination URL IP address represents the www.cisco.com website. The following figure depicts the HTTP GET operation.

Figure 5: HTTP Operation



Device B Configuration

```
ip sla 8
 http get url http://198.133.219.25
!
ip sla schedule 8 start-time now
```

Example Configuring an HTTP RAW Operation

The following example shows how to configure an HTTP RAW operation. To use the RAW commands, enter HTTP RAW configuration mode by using the **http-raw-request** command in IP SLA configuration mode. The IP SLA HTTP RAW configuration mode is indicated by the (config-ip-sla-http) router prompt.

```
ip sla 8
 http raw url http://198.133.219.25
 http-raw-request
 GET /en/US/hmpgs/index.html HTTP/1.0\r\n
 \r\n
 end
ip sla schedule 8 life forever start-time now
```

Example Configuring an HTTP RAW Operation Through a Proxy Server

The following example shows how to configure an HTTP RAW operation through a proxy server. The proxy server is www.proxy.cisco.com and the HTTP server is www.yahoo.com.

```
ip sla 8
 http raw url http://www.proxy.cisco.com
 http-raw-request
 GET http://www.yahoo.com HTTP/1.0\r\n
 \r\n
 end
ip sla schedule 8 life forever start-time now
```

Example Configuring an HTTP RAW Operation with Authentication

The following example shows how to configure an HTTP RAW operation with authentication.

```
ip sla 8
 http raw url http://site-test.cisco.com
 http-raw-request
 GET /lab/index.html HTTP/1.0\r\n
 Authorization: Basic btNpdGT4biNvoZe=\r\n
 \r\n
 end
ip sla schedule 8 life forever start-time now
```

Additional References

Related Documents

Related Topic	Document Title
Cisco IOS commands	Cisco IOS Master Commands List, All Releases
Cisco IOS IP SLAs commands	Cisco IOS IP SLAs Command Reference, All Releases

Related Topic	Document Title
Cisco IOS IP SLAs: general information	"Cisco IOS IP SLAs Overview" module of the *Cisco IOS IP SLAs Configuration Guide*.
Multioperation scheduling for IP SLAs	"Configuring Multioperation Scheduling of IP SLAs Operations" module of the *Cisco IOS P SLAs Configuration Guide*
Proactive threshold monitoring for IP SLAs	"Configuring Proactive Threshold Monitoring of IP SLAs Operations" module of the *Cisco IOS IP SLAs Configuration Guide*

MIBs

MIBs	MIBs Link
CISCO-RTTMON-MIB	To locate and download MIBs for selected platforms, Cisco IOS releases, and feature sets, use Cisco MIB Locator found at the following URL: http://www.cisco.com/go/mibs

Technical Assistance

Description	Link
The Cisco Support and Documentation website provides online resources to download documentation, software, and tools. Use these resources to install and configure the software and to troubleshoot and resolve technical issues with Cisco products and technologies. Access to most tools on the Cisco Support and Documentation website requires a Cisco.com user ID and password.	http://www.cisco.com/cisco/web/support/index.html

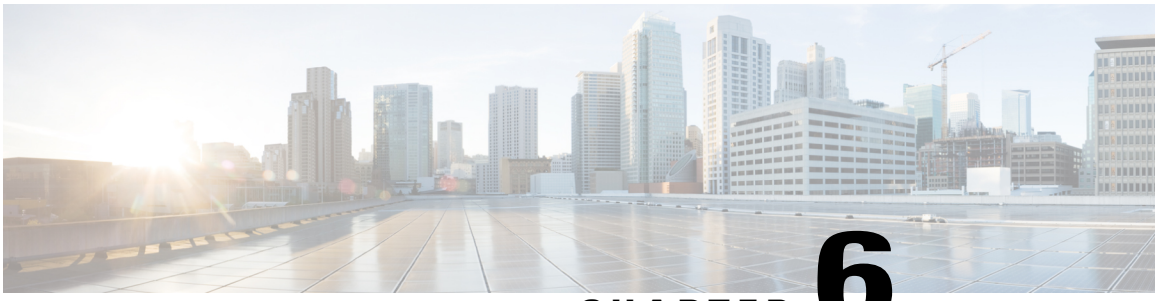
Feature Information for IP SLAs - HTTP Operations

The following table provides release information about the feature or features described in this module. This table lists only the software release that introduced support for a given feature in a given software release train. Unless noted otherwise, subsequent releases of that software release train also support that feature.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to . An account on Cisco.com is not required.

Table 12: Feature Information for IP SLAs HTTP Operations

Feature Name	Releases	Feature Information
IP SLAs HTTP Operation	Cisco IOS XE Release 3.2SE	The Cisco IOS IP SLAs Hypertext Transfer Protocol (HTTP) operation allows you to measure the network response time between a Cisco device and an HTTP server to retrieve a web page. In Cisco IOS XE Release 3.2SE, this feature was supported on the following platforms: • Catalyst 3650 Series Switches • Catalyst 3850 Series Switches • Cisco 5760 Wireless LAN Controller



CHAPTER 6

Configuring IP SLAs TCP Connect Operations

This module describes how to configure an IP Service Level Agreements (SLAs) TCP Connect operation to measure the response time taken to perform a TCP Connect operation between a Cisco router and devices using IPv4 or IPv6. TCP Connect accuracy is enhanced by using the IP SLAs Responder at the destination Cisco router. This module also demonstrates how the results of the TCP Connect operation can be displayed and analyzed to determine how the connection times to servers and hosts within your network can affect IP service levels. The TCP Connect operation is useful for measuring response times for a server used for a particular application or connectivity testing for server availability.

Finding Feature Information

Your software release may not support all the features documented in this module. For the latest caveats and feature information, see Bug Search Tool and the release notes for your platform and software release. To find information about the features documented in this module, and to see a list of the releases in which each feature is supported, see the feature information table.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to www.cisco.com/go/cfn. An account on Cisco.com is not required.

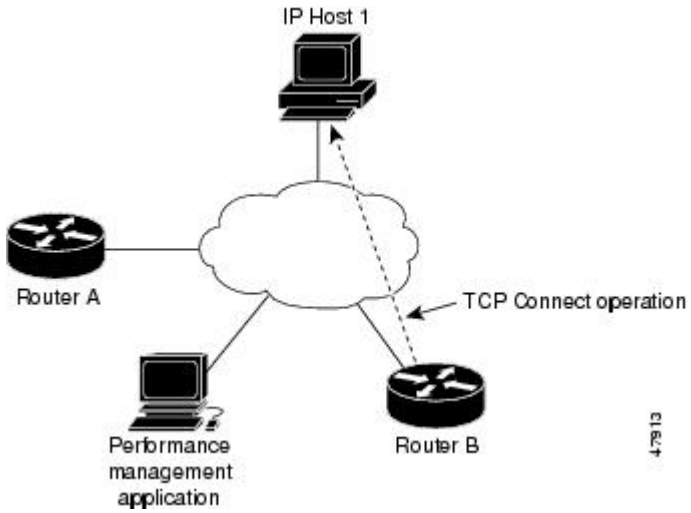
Information About the IP SLAs TCP Connect Operation

TCP Connect Operation

The IP SLAs TCP Connect operation measures the response time taken to perform a TCP Connect operation between a Cisco device and devices using IP. TCP is a transport layer (Layer 4) Internet protocol that provides reliable full-duplex data transmission. The destination device can be any device using IP or an IP SLAs Responder.

In the figure below Device B is configured as the source IP SLAs device and a TCP Connect operation is configured with the destination device as IP Host 1.

Figure 6: TCP Connect Operation



Connection response time is computed by measuring the time taken between sending a TCP request message from Device B to IP Host 1 and receiving a reply from IP Host 1.

TCP Connect accuracy is enhanced by using the IP SLAs Responder at the destination Cisco device. If the destination device is a Cisco device, then IP SLAs makes a TCP connection to any port number that you specified. If the destination is not a Cisco IP host, then you must specify a known destination port number such as 21 for FTP, 23 for Telnet, or 80 for an HTTP server.

Using the IP SLAs Responder is optional for a TCP Connect operation when using Cisco devices. The IP SLAs Responder cannot be configured on non-Cisco devices.

TCP Connect is used to test virtual circuit availability or application availability. Server and application connection performance can be tested by simulating Telnet, SQL, and other types of connection to help you verify your IP service levels.

How to Configure the IP SLAs TCP Connect Operation

Configuring the IP SLAs Responder on the Destination Device

Before You Begin

If you are using the IP SLAs Responder, ensure that the networking device to be used as the responder is a Cisco device and that you have connectivity to that device through the network.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. Do one of the following:
   - **ip sla responder**
   - **ip sla responder tcp-connect ipaddress** *ip-address* **port** *port*
4. **exit**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Device> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Device# configure terminal`	Enters global configuration mode.
Step 3	Do one of the following: • **ip sla responder** • **ip sla responder tcp-connect ipaddress** *ip-address* **port** *port* **Example:** `Device(config)# ip sla responder`	(Optional) Temporarily enables IP SLAs responder functionality on the Cisco device in response to control messages from source. or (Optional) Required only if protocol control is explicitly disabled on the source device. Permanently enables IP SLAs responder functionality on the specified IP address and port. • Control is enabled by default.

	Command or Action	Purpose
	Example: `Device(config)# ip sla responder tcp-connect ipaddress 172.29.139.132 port 5000`	
Step 4	**exit** **Example:** `Device(config)# exit`	(Optional) Exits global configuration mode and returns to privileged EXEC mode.

Configuring and Scheduling a TCP Connect Operation on the Source Device

Perform only one of the following tasks:

Prerequisites

If you are using the IP SLAs Responder, complete the "Configuring the IP SLAs Responder on the Destination Device" section before you start this task.

Configuring a Basic TCP Connect Operation on the Source Device

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **ip sla** *operation-number*
4. **tcp-connect** {*destination-ip-address* | *destination-hostname*} *destination-port* [**source-ip** {*ip-address* | *hostname*} **source-port** *port-number*] [**control** {**enable** | **disable**}]
5. **frequency** *seconds*
6. **end**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Device> enable`	Enables privileged EXEC mode. • Enter your password if prompted.

	Command or Action	Purpose
Step 2	**configure terminal** **Example:** `Device# configure terminal`	Enters global configuration mode.
Step 3	**ip sla** *operation-number* **Example:** `Device(config)# ip sla 10`	Begins configuration for an IP SLAs operation and enters IP SLA configuration mode.
Step 4	**tcp-connect** {*destination-ip-address* | *destination-hostname*} *destination-port* [**source-ip** {*ip-address* | *hostname*} **source-port** *port-number*] [**control** {**enable** | **disable**}] **Example:** `Device(config-ip-sla)# tcp-connect 172.29.139.132 5000`	Defines a TCP Connect operation and enters IP SLA TCP configuration mode. • Use the **control disable** keyword combination only if you disable the IP SLAs control protocol on both the source and target devices.
Step 5	**frequency** *seconds* **Example:** `Device(config-ip-sla-tcp)# frequency 30`	(Optional) Sets the rate at which a specified IP SLAs operation repeats.
Step 6	**end** **Example:** `Device(config-ip-sla-tcp)# end`	Returns to global configuration mode.

Configuring a TCP Connect Operation with Optional Parameters on the Source Device

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **ip sla** *operation-number*
4. **tcp-connect** {*destination-ip-address* | *destination-hostname*} *destination-port* [**source-ip** {*ip-address* | *hostname*} **source-port** *port-number*] [**control** {**enable** | **disable**}]
5. **history buckets-kept** *size*
6. **history distributions-of-statistics-kept** *size*
7. **history enhanced** [**interval** *seconds*] [**buckets** *number-of-buckets*]
8. **history filter** {**none** | **all** | **overThreshold** | **failures**}
9. **frequency** *seconds*
10. **history hours-of-statistics-kept** *hours*
11. **history lives-kept** *lives*
12. **owner** *owner-id*
13. **history statistics-distribution-interval** *milliseconds*
14. **tag** *text*
15. **threshold** *milliseconds*
16. **timeout** *milliseconds*
17. Do one of the following:
    - **tos** *number*
    - **traffic-class** *number*
18. **flow-label** *number*
19. **exit**
20. **show ip sla configuration** [*operation-number*]

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Device> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Device# configure terminal`	Enters global configuration mode.

	Command or Action	Purpose
Step 3	**ip sla** *operation-number* **Example:** `Device(config)# ip sla 10`	Begins configuration for an IP SLAs operation and enters IP SLA configuration mode.
Step 4	**tcp-connect** {*destination-ip-address* | *destination-hostname*} *destination-port* [**source-ip** {*ip-address* | *hostname*} **source-port** *port-number*] [**control** {**enable** | **disable**}] **Example:** `Device(config-ip-sla)# tcp-connect 172.29.139.132 5000`	Defines a TCP Connect operation and enters IP SLA TCP configuration mode. • Use the **control disable** keyword combination only if you disable the IP SLAs control protocol on both the source and target devices.
Step 5	**history buckets-kept** *size* **Example:** `Device(config-ip-sla-tcp)# history buckets-kept 25`	(Optional) Sets the number of history buckets that are kept during the lifetime of an IP SLAs operation.
Step 6	**history distributions-of-statistics-kept** *size* **Example:** `Device(config-ip-sla-tcp)# history distributions-of-statistics-kept 5`	(Optional) Sets the number of statistics distributions kept per hop during an IP SLAs operation.
Step 7	**history enhanced** [**interval** *seconds*] [**buckets** *number-of-buckets*] **Example:** `Device(config-ip-sla-tcp)# history enhanced interval 900 buckets 100`	(Optional) Enables enhanced history gathering for an IP SLAs operation.
Step 8	**history filter** {**none** | **all** | **overThreshold** | **failures**} **Example:** `Device(config-ip-sla-tcp)# history filter failures`	(Optional) Defines the type of information kept in the history table for an IP SLAs operation.
Step 9	**frequency** *seconds* **Example:** `Device(config-ip-sla-tcp)# frequency 30`	(Optional) Sets the rate at which a specified IP SLAs operation repeats.
Step 10	**history hours-of-statistics-kept** *hours* **Example:** `Device(config-ip-sla-tcp)# history hours-of-statistics-kept 4`	(Optional) Sets the number of hours for which statistics are maintained for an IP SLAs operation.

	Command or Action	Purpose
Step 11	**history lives-kept** *lives* **Example:** `Device(config-ip-sla-tcp)# history lives-kept 2`	(Optional) Sets the number of lives maintained in the history table for an IP SLAs operation.
Step 12	**owner** *owner-id* **Example:** `Device(config-ip-sla-tcp)# owner admin`	(Optional) Configures the Simple Network Management Protocol (SNMP) owner of an IP SLAs operation.
Step 13	**history statistics-distribution-interval** *milliseconds* **Example:** `Device(config-ip-sla-tcp)# history statistics-distribution-interval 10`	(Optional) Sets the time interval for each statistics distribution kept for an IP SLAs operation.
Step 14	**tag** *text* **Example:** `Device(config-ip-sla-tcp)# tag TelnetPollServer1`	(Optional) Creates a user-specified identifier for an IP SLAs operation.
Step 15	**threshold** *milliseconds* **Example:** `Device(config-ip-sla-tcp)# threshold 10000`	(Optional) Sets the upper threshold value for calculating network monitoring statistics created by an IP SLAs operation.
Step 16	**timeout** *milliseconds* **Example:** `Device(config-ip-sla-tcp)# timeout 10000`	(Optional) Sets the amount of time an IP SLAs operation waits for a response from its request packet.

Step 17	Do one of the following:
	• **tos** *number*
	• **traffic-class** *number*
	Example:
	`Device(config-ip-sla-jitter)# tos 160`
	Example:
	`Device(config-ip-sla-jitter)# traffic-class 160`
		(Optional) For IPv4: Defines the ToS byte in the IPv4 header of an IP SLAs operation.
		or
		(Optional) For IPv6: Defines the traffic class byte in the IPv6 header for a supported IP SLAs operation.

Step 18	**flow-label** *number* **Example:** `Device(config-ip-sla-tcp)# flow-label 112233`	(Optional) For IPv6: Defines the flow label field in the IPv6 header for a supported IP SLAs operation.

	Command or Action	Purpose
Step 19	**exit** **Example:** `Device(config-ip-sla-tcp)# exit`	Exits TCP configuration submode and returns to global configuration mode.
Step 20	**show ip sla configuration** [*operation-number*] **Example:** `Device# show ip sla configuration 10`	(Optional) Displays configuration values including all defaults for all IP SLAs operations or a specified operation.

Scheduling IP SLAs Operations

Before You Begin

- All IP Service Level Agreements (SLAs) operations to be scheduled must be already configured.
- The frequency of all operations scheduled in a multioperation group must be the same.
- The list of one or more operation ID numbers to be added to a multioperation group must be limited to a maximum of 125 characters in length, including commas (,).

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. Enter one of the following commands:
   - **ip sla schedule** *operation-number* [**life** {**forever** | *seconds*}] [**start-time** {[*hh*:*mm*:*ss*] [*month day* | *day month*] | **pending** | **now** | **after** *hh*:*mm*:*ss*}] [**ageout** *seconds*] [**recurring**]
   - **ip sla group schedule** *group-operation-number operation-id-numbers* {**schedule-period** *schedule-period-range* | **schedule-together**} [**ageout** *seconds*] [**frequency** *group-operation-frequency*] [**life** {**forever** | *seconds*}] [**start-time** {*hh*:*mm* [:*ss*] [*month day* | *day month*] | **pending** | **now** | **after** *hh*:*mm* [:*ss*]}]
4. **end**
5. **show ip sla group schedule**
6. **show ip sla configuration**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable**	Enables privileged EXEC mode.

	Command or Action	Purpose
	Example: `Device> enable`	• Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Device# configure terminal`	Enters global configuration mode.

Step 3	Enter one of the following commands:
	• **ip sla schedule** *operation-number* [**life** {**forever** | *seconds*}] [**start-time** {[*hh*:*mm*:*ss*] [*month day* | *day month*] | **pending** | **now** | **after** *hh*:*mm*:*ss*}] [**ageout** *seconds*] [**recurring**]
	• **ip sla group schedule** *group-operation-number operation-id-numbers* {**schedule-period** *schedule-period-range* | **schedule-together**} [**ageout** *seconds*] [**frequency** *group-operation-frequency*] [**life** {**forever** | *seconds*}] [**start-time** {*hh*:*mm* [:*ss*] [*month day* | *day month*] | **pending** | **now** | **after** *hh*:*mm* [:*ss*]}]
	Example:
	`Device(config)# ip sla schedule 10 life forever start-time now`
	`Device(config)# ip sla group schedule 10 schedule-period frequency`
	`Device(config)# ip sla group schedule 1 3,4,6-9 life forever start-time now`
	`Device(config)# ip sla schedule 1 3,4,6-9 schedule-period 50 frequency range 80-100`
		• Configures the scheduling parameters for an individual IP SLAs operation.
		• Specifies an IP SLAs operation group number and the range of operation numbers for a multioperation scheduler.

Step 4	**end** **Example:** `Device(config)# end`	Exits global configuration mode and returns to privileged EXEC mode.
Step 5	**show ip sla group schedule** **Example:** `Device# show ip sla group schedule`	(Optional) Displays IP SLAs group schedule details.

	Command or Action	Purpose
Step 6	**show ip sla configuration** **Example:** `Device# show ip sla configuration`	(Optional) Displays IP SLAs configuration details.

Troubleshooting Tips

- If the IP Service Level Agreements (SLAs) operation is not running and not generating statistics, add the **verify-data** command to the configuration (while configuring in IP SLA configuration mode) to enable data verification. When data verification is enabled, each operation response is checked for corruption. Use the **verify-data** command with caution during normal operations because it generates unnecessary overhead.
- Use the **debug ip sla trace** and **debug ip sla error** commands to help troubleshoot issues with an IP SLAs operation.

What to Do Next

To add proactive threshold conditions and reactive triggering for generating traps (or for starting another operation) to an IP Service Level Agreements (SLAs) operation, see the “Configuring Proactive Threshold Monitoring” section.

Configuration Examples for IP SLAs TCP Connect Operations

Example Configuring a TCP Connect Operation

The following example shows how to configure a TCP Connect operation from Device B to the Telnet port (TCP port 23) of IP Host 1 (IP address 10.0.0.1), as shown in the "TCP Connect Operation" figure in the "Information About the IP SLAs TCP Connect Operation" section. The operation is scheduled to start immediately. In this example, the control protocol is disabled on the source (Device B). IP SLAs uses the control protocol to notify the IP SLAs responder to enable the target port temporarily. This action allows the responder to reply to the TCP Connect operation. In this example, because the target is not a Cisco device and a well-known TCP port is used, there is no need to send the control message.

Device A (target device) Configuration

```
configure terminal
 ip sla responder tcp-connect ipaddress 10.0.0.1 port 23
```

Device B (source device) Configuration

```
ip sla 9
 tcp-connect 10.0.0.1 23 control disable
 frequency 30
 tos 128
 timeout 1000
 tag FLL-RO
ip sla schedule 9 start-time now
```

The following example shows how to configure a TCP Connect operation with a specific port, port 23, and without an IP SLAs responder. The operation is scheduled to start immediately and run indefinitely.

```
ip sla 9
 tcp-connect 173.29.139.132 21 control disable
 frequency 30
ip sla schedule 9 life forever start-time now
```

Additional References

Related Documents

Related Topic	Document Title
Cisco IOS commands	Cisco IOS Master Commands List, All Releases
Cisco IOS IP SLAs commands	Cisco IOS IP SLAs Command Reference, All Releases
Cisco IOS IP SLAs: general information	"Cisco IOS IP SLAs Overview" module of the *Cisco IOS IP SLAs Configuration Guide*.
Multioperation scheduling for IP SLAs	"Configuring Multioperation Scheduling of IP SLAs Operations" module of the *Cisco IOS P SLAs Configuration Guide*
Proactive threshold monitoring for IP SLAs	"Configuring Proactive Threshold Monitoring of IP SLAs Operations" module of the *Cisco IOS IP SLAs Configuration Guide*

MIBs

MIBs	MIBs Link
CISCO-RTTMON-MIB	To locate and download MIBs for selected platforms, Cisco IOS releases, and feature sets, use Cisco MIB Locator found at the following URL: http://www.cisco.com/go/mibs

Technical Assistance

Description	Link
The Cisco Support and Documentation website provides online resources to download documentation, software, and tools. Use these resources to install and configure the software and to troubleshoot and resolve technical issues with Cisco products and technologies. Access to most tools on the Cisco Support and Documentation website requires a Cisco.com user ID and password.	http://www.cisco.com/cisco/web/support/index.html

Feature Information for the IP SLAs TCP Connect Operation

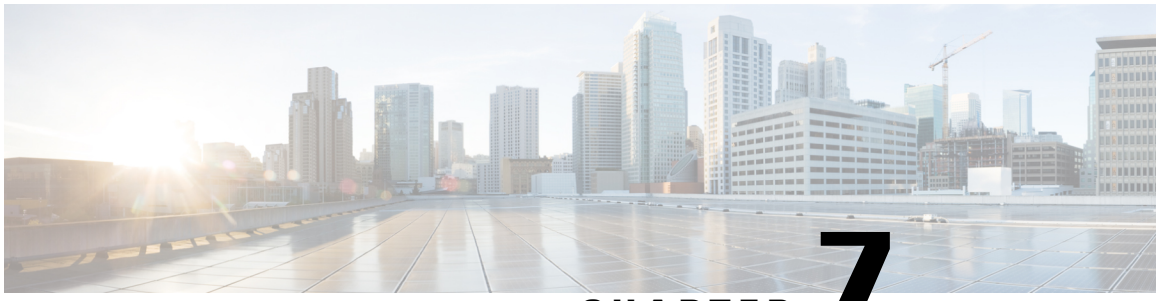
The following table provides release information about the feature or features described in this module. This table lists only the software release that introduced support for a given feature in a given software release train. Unless noted otherwise, subsequent releases of that software release train also support that feature.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to . An account on Cisco.com is not required.

Table 13: Feature Information for the IP SLAs TCP Connect Operation

Feature Name	Releases	Feature Information
IP SLAs TCP Connect Operation	Cisco IOS XE Release 3.2SE	The Cisco IOS IP SLAs Transmission Control Protocol (TCP) connect operation allows you to measure the network response time taken to perform a TCP Connect operation between a Cisco device and other devices using IP. In Cisco IOS XE Release 3.2SE, this feature was supported on the following platforms: • Catalyst 3650 Series Switches • Catalyst 3850 Series Switches • Cisco 5760 Wireless LAN Controller

Feature Name	Releases	Feature Information
IPv6 - IP SLAs (UDP Jitter, UDP Echo, ICMP Echo, TCP Connect)	Cisco IOS XE Release 3.2SE	Support was added for operability in IPv6 networks. In Cisco IOS XE Release 3.2SE, this feature was supported on the following platforms: • Catalyst 3650 Series Switches • Catalyst 3850 Series Switches • Cisco 5760 Wireless LAN Controller
IP SLAs VRF Aware 2.0	Cisco IOS XE Release 3.2SE	Support was added for IP SLAs VRF-aware capabilities for TCP connect, FTP, HTTP and DNS client operation types. In Cisco IOS XE Release 3.2SE, this feature was supported on the following platforms: • Catalyst 3650 Series Switches • Catalyst 3850 Series Switches • Cisco 5760 Wireless LAN Controller



CHAPTER 7

Configuring Cisco IP SLAs ICMP Jitter Operations

This module describes how to configure a Cisco IOS IP Service Level Agreements (SLAs) Internet Control Message Protocol (ICMP) Jitter operation for generating a stream of ICMP packets between a Cisco IOS device (source) and any other IP device (destination) to gather network performance-related statistics. The destination device can be any network device that supports ICMP such as a server or workstation. Available statistical measurements for IP SLAs ICMP jitter operations include latency, round-trip time, jitter (interpacket delay variance), and packet loss. The IP SLAs ICMP jitter operation does not require an IP SLAs Responder on the destination device.

Finding Feature Information

Your software release may not support all the features documented in this module. For the latest caveats and feature information, see Bug Search Tool and the release notes for your platform and software release. To find information about the features documented in this module, and to see a list of the releases in which each feature is supported, see the feature information table.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to www.cisco.com/go/cfn. An account on Cisco.com is not required.

Restrictions for IP SLAs ICMP Jitter Operations

- Cisco IOS-XR devices do not support ICMP Timestamp and hence all ICMP jitter operations to these devices fail.

- When compared to the IP SLAs User Datagram Protocol (UDP) jitter operation, the IP SLAs ICMP jitter operation may provide less accurate measurements because the accuracy of the measurements provided by a non-Cisco destination device cannot be determined.
- Because ICMP packets do not support voice technology, the IP SLAs ICMP jitter operation does not support Mean Opinion Score (MOS), Calculated Planning Impairment Factor (ICPIF), or estimated transmission rating factor (R) reaction configuration capabilities.

Information About IP SLAs ICMP Jitter Operations

Benefits of the IP SLAs ICMP Jitter Operation

The IP SLAs ICMP Jitter Operation feature provides the following key benefits:

- End-to-end performance measurements between a Cisco device (source) and any other IP device (destination) using ICMP.
- Proactive threshold violation monitoring through Simple Network Management Protocol (SNMP) trap notifications and syslog messages.

Statistics Measured by the IP SLAs ICMP Jitter Operation

The IP SLAs ICMP jitter operation supports the following statistical measurements:

- Jitter (source-to-destination and destination-to-source)
- Latency (source-to-destination and destination-to-source)
- Round-trip time latency
- Packet loss
- Successive packet loss
- Out-of-sequence packets (source-to-destination, destination-to-source, and round-trip)
- Late packets

IP SLAs ICMP jitter uses a two ICMP time stamp messages, an ICMP Timestamp Request (Type 13) and an ICMP Timestamp Reply (Type 14), to provide jitter, packet loss, and latency. IP SLAs ICMP jitter operations differ from IP SLAs ICMP echo operations in that ICMP echo uses ICMP Echo request and reply (ping). Devices that are fully compliant with RFC 792, *Internet Control Message Protocol* , must be able to respond to the time stamp messages without requiring an IP SLA responder at the destination.

Note Cisco IOS devices support RFC 792's timestamp requests and replies, but Cisco IOS-XR devices do not support this.

The ICMP API sends a configurable number of request message packets out of the interface. The data (time stamp) that is received in the request is returned in a reply message packet along with another time stamp.

Every packet includes three time stamps: an Originate (sent) Timestamp, a Receive Timestamp, and a Transmit (reply) Timestamp.

IP SLAs utilizes the time stamps to calculate jitter for each direction, based on the difference between interarrival and interdeparture delay for two successive packets. If the difference is positive, it is counted in positive jitter. A negative value is counted in negative jitter. Separate measurements for the source-to-destination and destination-to-source data paths can be used to identify problems in your network because the paths can be different (asymmetric).

Each ICMP packet includes a sequence number in its header that is used to count the number of packets received out of sequence on the sender. Both the sequence number and the receive timestamps can be used to calculate out-of-sequence packets on the source-to-destination path. If the receive time stamp for a packet is greater than that of the next packet, the first packet was delivered out of order on the source-to-destination path. For the destination-to-source path, the same method can be applied. Note that if the packet is out of order on the source-to-destination path, it should be returned out of order to the sender unless there is also misordering on the destination-to-source path.

If any packet cannot be sent due to an internal or unexpected error, or because the timerwheel slot containing the packet is missed, it is counted as Packet Skipped. This metric is very important because statistics are measured on sent packets only.

All timed-out packets are counted towards Packet Loss. Successive packet loss is calculated by counting, and adding, the number of successive dropped packets. Successive packet loss is reported as minimum of successive packet drop and maximum of successive packet drop.

All other statistics are calculated using the same logic as a UDP jitter operation.

How to Configure IP SLAs ICMP Jitter Operations

Scheduling IP SLAs Operations

Before You Begin

- All IP Service Level Agreements (SLAs) operations to be scheduled must be already configured.
- The frequency of all operations scheduled in a multioperation group must be the same.
- The list of one or more operation ID numbers to be added to a multioperation group must be limited to a maximum of 125 characters in length, including commas (,).

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. Enter one of the following commands:
   - **ip sla schedule** *operation-number* [**life** {**forever** | *seconds*}] [**start-time** {[*hh*:*mm*:*ss*] [*month day* | *day month*] | **pending** | **now** | **after** *hh*:*mm*:*ss*}] [**ageout** *seconds*] [**recurring**]
   - **ip sla group schedule** *group-operation-number operation-id-numbers* {**schedule-period** *schedule-period-range* | **schedule-together**} [**ageout** *seconds*] [**frequency** *group-operation-frequency*] [**life** {**forever** | *seconds*}] [**start-time** {*hh*:*mm* [:*ss*] [*month day* | *day month*] | **pending** | **now** | **after** *hh*:*mm* [:*ss*]}]
4. **end**
5. **show ip sla group schedule**
6. **show ip sla configuration**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Device> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Device# configure terminal`	Enters global configuration mode.
Step 3	Enter one of the following commands: • **ip sla schedule** *operation-number* [**life** {**forever**	*seconds*}] [**start-time** {[*hh*:*mm*:*ss*] [*month day*	*day month*]	**pending**	**now**	**after** *hh*:*mm*:*ss*}] [**ageout** *seconds*] [**recurring**] • **ip sla group schedule** *group-operation-number operation-id-numbers* {**schedule-period** *schedule-period-range*	**schedule-together**} [**ageout** *seconds*] [**frequency** *group-operation-frequency*] [**life** {**forever**	*seconds*}] [**start-time** {*hh*:*mm* [:*ss*] [*month day*	*day month*]	**pending**	**now**	**after** *hh*:*mm* [:*ss*]}]	• Configures the scheduling parameters for an individual IP SLAs operation. • Specifies an IP SLAs operation group number and the range of operation numbers for a multioperation scheduler.

	Command or Action	Purpose

	Example:
	`Device(config)# ip sla schedule 10 life forever start-time now`
	`Device(config)# ip sla group schedule 10 schedule-period frequency`
	`Device(config)# ip sla group schedule 1 3,4,6-9 life forever start-time now`
	`Device(config)# ip sla schedule 1 3,4,6-9 schedule-period 50 frequency range 80-100`	

Step 4	**end** **Example:** `Device(config)# end`	Exits global configuration mode and returns to privileged EXEC mode.
Step 5	**show ip sla group schedule** **Example:** `Device# show ip sla group schedule`	(Optional) Displays IP SLAs group schedule details.
Step 6	**show ip sla configuration** **Example:** `Device# show ip sla configuration`	(Optional) Displays IP SLAs configuration details.

Troubleshooting Tips

- If the IP Service Level Agreements (SLAs) operation is not running and not generating statistics, add the **verify-data** command to the configuration (while configuring in IP SLA configuration mode) to enable data verification. When data verification is enabled, each operation response is checked for corruption. Use the **verify-data** command with caution during normal operations because it generates unnecessary overhead.
- Use the **debug ip sla trace** and **debug ip sla error** commands to help troubleshoot issues with an IP SLAs operation.

What to Do Next

To add proactive threshold conditions and reactive triggering for generating traps (or for starting another operation) to an IP Service Level Agreements (SLAs) operation, see the "Configuring Proactive Threshold Monitoring" section.

Configuration Examples for IP SLAs ICMP Jitter Operations

Additional References

Related Documents

Related Topic	Document Title
Cisco IOS commands	Cisco IOS Master Command List, All Releases
Cisco IOS IP SLAs commands	IP SLAs Command Reference
Cisco IOS IP SLAs: general information	Cisco IOS IP SLAs Overview chapter of the *Cisco IOS IP SLAs Configuration Guide*.

Standards

Standard	Title
No new or modified standards are supported by this feature, and support for existing standards has not been modified by this feature.	--

MIBs

MIB	MIBs Link
• CISCO-RTTMON-MIB • CISCO-RTTMON-ICMP-MIB	To locate and download MIBs for selected platforms, Cisco software releases, and feature sets, use Cisco MIB Locator found at the following URL: http://www.cisco.com/go/mibs

RFCs

RFC	Title
RFC 792	*Internet Control Message Protocol*

Technical Assistance

Description	Link
The Cisco Support and Documentation website provides online resources to download documentation, software, and tools. Use these resources to install and configure the software and to troubleshoot and resolve technical issues with Cisco products and technologies. Access to most tools on the Cisco Support and Documentation website requires a Cisco.com user ID and password.	http://www.cisco.com/cisco/web/support/index.html

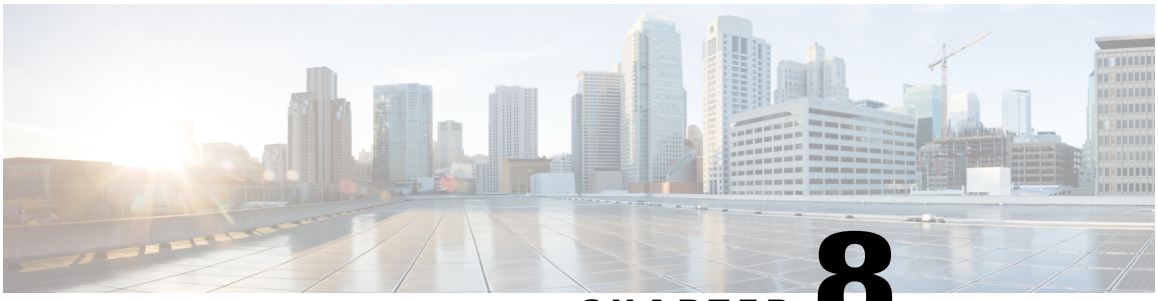
Feature Information for IP SLAs - ICMP Jitter Operation

The following table provides release information about the feature or features described in this module. This table lists only the software release that introduced support for a given feature in a given software release train. Unless noted otherwise, subsequent releases of that software release train also support that feature.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to . An account on Cisco.com is not required.

Table 14: Feature Information for IP SLAs - ICMP Jitter Operation

Feature Name	Releases	Feature Information
IP SLAs ICMP Jitter Operation	Cisco IOS XE Release 3.2SE	The Cisco IOS IP Service Level Agreements (SLAs) Internet Control Message Protocol (ICMP) jitter operation provides the capability to generate a stream of ICMP packets between a Cisco IOS device (source) and any other IP device (destination) to gather network performance-related statistics. Available statistical measurements for the IP SLAs ICMP jitter operation include latency, round-trip time, jitter (interpacket delay variance), and packet loss. In Cisco IOS XE Release 3.2SE, this feature was supported on the following platforms: • Catalyst 3650 Series Switches • Catalyst 3850 Series Switches • Cisco 5760 Wireless LAN Controller



CHAPTER 8

Configuring IP SLAs ICMP Echo Operations

This module describes how to configure an IP Service Level Agreements (SLAs) Internet Control Message Protocol (ICMP) Echo operation to monitor end-to-end response time between a Cisco router and devices using IPv4 or IPv6. ICMP Echo is useful for troubleshooting network connectivity issues. This module also demonstrates how the results of the ICMP Echo operation can be displayed and analyzed to determine how the network IP connections are performing.

Finding Feature Information

Your software release may not support all the features documented in this module. For the latest caveats and feature information, see Bug Search Tool and the release notes for your platform and software release. To find information about the features documented in this module, and to see a list of the releases in which each feature is supported, see the feature information table.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to www.cisco.com/go/cfn. An account on Cisco.com is not required.

Restrictions for IP SLAs ICMP Echo Operations

We recommend using a Cisco networking device as the destination device although any networking device that supports RFC 862, Echo protocol, can be used.

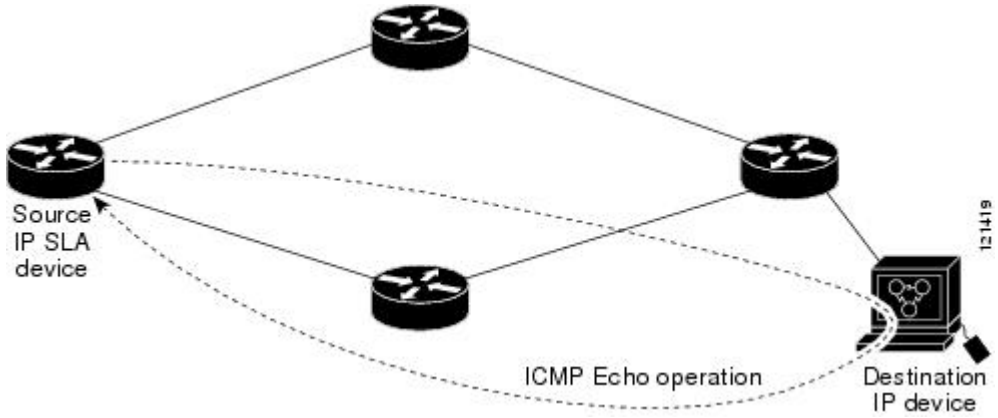
Information About IP SLAs ICMP Echo Operations

ICMP Echo Operation

The ICMP Echo operation measures end-to-end response time between a Cisco router and any devices using IP. Response time is computed by measuring the time taken between sending an ICMP Echo request message to the destination and receiving an ICMP Echo reply.

In the figure below ping is used by the ICMP Echo operation to measure the response time between the source IP SLAs device and the destination IP device. Many customers use IP SLAs ICMP-based operations, in-house ping testing, or ping-based dedicated probes for response time measurements.

Figure 7: ICMP Echo Operation



The IP SLAs ICMP Echo operation conforms to the same IETF specifications for ICMP ping testing and the two methods result in the same response times.

How to Configure IP SLAs ICMP Echo Operations

Configuring an ICMP Echo Operation

Note There is no need to configure an IP SLAs responder on the destination device.

Perform one of the following tasks:

Configuring a Basic ICMP Echo Operation on the Source Device

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **ip sla** *operation-number*
4. **icmp-echo** {*destination-ip-address* | *destination-hostname*} [**source-ip** {*ip-address* | *hostname*} | **source-interface** *interface-name*]
5. **frequency** *seconds*
6. **end**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Device> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Device# configure terminal`	Enters global configuration mode.
Step 3	**ip sla** *operation-number* **Example:** `Device(config)# ip sla 6`	Begins configuration for an IP SLAs operation and enters IP SLA configuration mode.
Step 4	**icmp-echo** {*destination-ip-address* | *destination-hostname*} [**source-ip** {*ip-address* | *hostname*} | **source-interface** *interface-name*] **Example:** `Device(config-ip-sla)# icmp-echo 172.29.139.134`	Defines an ICMP Echo operation and enters IP SLA ICMP Echo configuration mode.
Step 5	**frequency** *seconds* **Example:** `Device(config-ip-sla-echo)# frequency 300`	(Optional) Sets the rate at which a specified IP SLAs operation repeats.

	Command or Action	Purpose
Step 6	**end** **Example:** `Device(config-ip-sla-echo)# end`	Exits to privileged EXEC mode.

What to Do Next

To add proactive threshold conditions and reactive triggering for generating traps, or for starting another operation, to an IP SLAs operation, see the "Configuring Proactive Threshold Monitoring" section.

Configuring an ICMP Echo Operation with Optional Parameters

Perform this task on the source device.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **ip sla** *operation-number*
4. **icmp-echo** {*destination-ip-address* | *destination-hostname*} [**source-ip** {*ip-address* | *hostname*} | **source-interface** *interface-name*]
5. **history buckets-kept** *size*
6. **history distributions-of-statistics-kept** *size*
7. **history enhanced** [**interval** *seconds*] [**buckets** *number-of-buckets*]
8. **history filter** {**none** | **all** | **overThreshold** | **failures**}
9. **frequency** *seconds*
10. **history hours-of-statistics-kept** *hours*
11. **history lives-kept** *lives*
12. **owner** *owner-id*
13. **request-data-size** *bytes*
14. **history statistics-distribution-interval** *milliseconds*
15. **tag** *text*
16. **threshold** *milliseconds*
17. **timeout** *milliseconds*
18. Do one of the following:
    - **tos** *number*
    - **traffic-class** *number*
19. **flow-label** *number*
20. **verify-data**
21. **vrf** *vrf-name*
22. **end**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Device> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Device# configure terminal`	Enters global configuration mode.

	Command or Action	Purpose
Step 3	**ip sla** *operation-number* **Example:** `Device(config)# ip sla 6`	Begins configuration for an IP SLAs operation and enters IP SLA configuration mode.
Step 4	**icmp-echo** {*destination-ip-address* | *destination-hostname*} [**source-ip** {*ip-address* | *hostname*} | **source-interface** *interface-name*] **Example:** `Device(config-ip-sla)# icmp-echo 172.29.139.134 source-ip 172.29.139.132`	Defines an Echo operation and enters IP SLA Echo configuration mode.
Step 5	**history buckets-kept** *size* **Example:** `Device(config-ip-sla-echo)# history buckets-kept 25`	(Optional) Sets the number of history buckets that are kept during the lifetime of an IP SLAs operation.
Step 6	**history distributions-of-statistics-kept** *size* **Example:** `Device(config-ip-sla-echo)# history distributions-of-statistics-kept 5`	(Optional) Sets the number of statistics distributions kept per hop during an IP SLAs operation.
Step 7	**history enhanced** [**interval** *seconds*] [**buckets** *number-of-buckets*] **Example:** `Device(config-ip-sla-echo)# history enhanced interval 900 buckets 100`	(Optional) Enables enhanced history gathering for an IP SLAs operation.
Step 8	**history filter** {**none** | **all** | **overThreshold** | **failures**} **Example:** `Device(config-ip-sla-echo)# history filter failures`	(Optional) Defines the type of information kept in the history table for an IP SLAs operation.
Step 9	**frequency** *seconds* **Example:** `Device(config-ip-sla-echo)# frequency 30`	(Optional) Sets the rate at which a specified IP SLAs operation repeats.

	Command or Action	Purpose
Step 10	**history hours-of-statistics-kept** *hours* **Example:** `Device(config-ip-sla-echo)# history hours-of-statistics-kept 4`	(Optional) Sets the number of hours for which statistics are maintained for an IP SLAs operation.
Step 11	**history lives-kept** *lives* **Example:** `Device(config-ip-sla-echo)# history lives-kept 5`	(Optional) Sets the number of lives maintained in the history table for an IP SLAs operation.
Step 12	**owner** *owner-id* **Example:** `Device(config-ip-sla-echo)# owner admin`	(Optional) Configures the Simple Network Management Protocol (SNMP) owner of an IP SLAs operation.
Step 13	**request-data-size** *bytes* **Example:** `Device(config-ip-sla-echo)# request-data-size 64`	(Optional) Sets the protocol data size in the payload of an IP SLAs operation's request packet.
Step 14	**history statistics-distribution-interval** *milliseconds* **Example:** `Device(config-ip-sla-echo)# history statistics-distribution-interval 10`	(Optional) Sets the time interval for each statistics distribution kept for an IP SLAs operation.
Step 15	**tag** *text* **Example:** `Device(config-ip-sla-echo)# tag TelnetPollServer1`	(Optional) Creates a user-specified identifier for an IP SLAs operation.
Step 16	**threshold** *milliseconds* **Example:** `Device(config-ip-sla-echo)# threshold 10000`	(Optional) Sets the upper threshold value for calculating network monitoring statistics created by an IP SLAs operation.
Step 17	**timeout** *milliseconds* **Example:** `Device(config-ip-sla-echo)# timeout 10000`	(Optional) Sets the amount of time an IP SLAs operation waits for a response from its request packet.

	Command or Action	Purpose

Step 18	Do one of the following:
	• **tos** *number*
	• **traffic-class** *number*
	Example:
	`Device(config-ip-sla-jitter)# tos 160`
	Example:
	`Device(config-ip-sla-jitter)# traffic-class 160`
		(Optional) In an IPv4 network only, defines the ToS byte in the IPv4 header of an IP SLAs operation.
		or
		(Optional) In an IPv6 network only, defines the traffic class byte in the IPv6 header for a supported IP SLAs operation.

Step 19	**flow-label** *number* **Example:** `Device(config-ip-sla-echo)# flow-label 112233`	(Optional) In an IPv6 network only, defines the flow label field in the IPv6 header for a supported IP SLAs operation.
Step 20	**verify-data** **Example:** `Device(config-ip-sla-echo)# verify-data`	(Optional) Causes an IP SLAs operation to check each reply packet for data corruption.
Step 21	**vrf** *vrf-name* **Example:** `Device(config-ip-sla-echo)# vrf vpn-A`	(Optional) Allows monitoring within Multiprotocol Label Switching (MPLS) Virtual Private Networks (VPNs) using IP SLAs operations.
Step 22	**end** **Example:** `Device(config-ip-sla-echo)# end`	Exits to privileged EXEC mode.

What to Do Next

To add proactive threshold conditions and reactive triggering for generating traps, or for starting another operation, to an IP SLAs operation, see the "Configuring Proactive Threshold Monitoring" section.

Scheduling IP SLAs Operations

Before You Begin

- All IP Service Level Agreements (SLAs) operations to be scheduled must be already configured.
- The frequency of all operations scheduled in a multioperation group must be the same.
- The list of one or more operation ID numbers to be added to a multioperation group must be limited to a maximum of 125 characters in length, including commas (,).

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. Enter one of the following commands:
   - **ip sla schedule** *operation-number* [**life** {**forever** | *seconds*}] [**start-time** {[*hh*:*mm*:*ss*] [*month day* | *day month*] | **pending** | **now** | **after** *hh*:*mm*:*ss*}] [**ageout** *seconds*] [**recurring**]
   - **ip sla group schedule** *group-operation-number operation-id-numbers* {**schedule-period** *schedule-period-range* | **schedule-together**} [**ageout** *seconds*] [**frequency** *group-operation-frequency*] [**life** {**forever** | *seconds*}] [**start-time** {*hh*:*mm* [:*ss*] [*month day* | *day month*] | **pending** | **now** | **after** *hh*:*mm* [:*ss*]}]
4. **end**
5. **show ip sla group schedule**
6. **show ip sla configuration**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Device> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Device# configure terminal`	Enters global configuration mode.
Step 3	Enter one of the following commands: • **ip sla schedule** *operation-number* [**life** {**forever**	*seconds*}] [**start-time** {[*hh*:*mm*:*ss*] [*month day*	*day month*]	**pending**	**now**	**after** *hh*:*mm*:*ss*}] [**ageout** *seconds*] [**recurring**]	• Configures the scheduling parameters for an individual IP SLAs operation. • Specifies an IP SLAs operation group number and the range of operation numbers for a multioperation scheduler.

	Command or Action	Purpose

	• **ip sla group schedule** *group-operation-number operation-id-numbers* {**schedule-period** *schedule-period-range* | **schedule-together**} [**ageout** *seconds*] [**frequency** *group-operation-frequency*] [**life** {**forever** | *seconds*}] [**start-time** {*hh*:*mm* [:*ss*] [*month day* | *day month*] | **pending** | **now** | **after** *hh*:*mm* [:*ss*]}]
	
	Example:
	`Device(config)# ip sla schedule 10 life forever start-time now`
	`Device(config)# ip sla group schedule 10 schedule-period frequency`
	`Device(config)# ip sla group schedule 1 3,4,6-9 life forever start-time now`
	`Device(config)# ip sla schedule 1 3,4,6-9 schedule-period 50 frequency range 80-100`	

Step 4	**end** **Example:** `Device(config)# end`	Exits global configuration mode and returns to privileged EXEC mode.
Step 5	**show ip sla group schedule** **Example:** `Device# show ip sla group schedule`	(Optional) Displays IP SLAs group schedule details.
Step 6	**show ip sla configuration** **Example:** `Device# show ip sla configuration`	(Optional) Displays IP SLAs configuration details.

Troubleshooting Tips

- If the IP Service Level Agreements (SLAs) operation is not running and not generating statistics, add the **verify-data** command to the configuration (while configuring in IP SLA configuration mode) to enable data verification. When data verification is enabled, each operation response is checked for corruption. Use the **verify-data** command with caution during normal operations because it generates unnecessary overhead.

- Use the **debug ip sla trace** and **debug ip sla error** commands to help troubleshoot issues with an IP SLAs operation.

What to Do Next

To add proactive threshold conditions and reactive triggering for generating traps (or for starting another operation) to an IP Service Level Agreements (SLAs) operation, see the "Configuring Proactive Threshold Monitoring" section.

Configuration Examples for IP SLAs ICMP Echo Operations

Example Configuring an ICMP Echo Operation

The following example shows how to configure an IP SLAs operation type of ICMP Echo that will start immediately and run indefinitely.

```
ip sla 6
 icmp-echo 172.29.139.134 source-ip 172.29.139.132
 frequency 300
 request-data-size 28
 tos 160
 timeout 2000
 tag SFO-RO
ip sla schedule 6 life forever start-time now
```

Additional References for IP SLAs ICMP Echo Operations

Related Documents

Related Topic	Document Title
Cisco IOS commands	Cisco IOS Master Commands List, All Releases
IP SLAs commands	Cisco IOS IP SLAs Command Reference
Information about Cisco IP SLAs	"Cisco IOS IP SLAs Overview" module of the *IP SLAs Configuration Guide*

Standards and RFCs

Standard/RFC	Title
RFC 862	Echo Protocol

MIBs

MIBs	MIBs Link
CISCO-RTTMON-MIB	To locate and download MIBs for selected platforms, Cisco IOS releases, and feature sets, use Cisco MIB Locator found at the following URL: http://www.cisco.com/go/mibs

Technical Assistance

Description	Link
The Cisco Support and Documentation website provides online resources to download documentation, software, and tools. Use these resources to install and configure the software and to troubleshoot and resolve technical issues with Cisco products and technologies. Access to most tools on the Cisco Support and Documentation website requires a Cisco.com user ID and password.	http://www.cisco.com/cisco/web/support/index.html

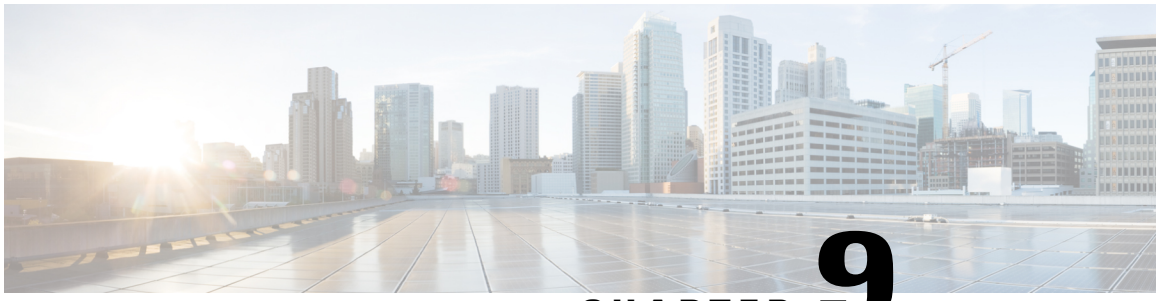
Feature Information for IP SLAs ICMP Echo Operations

The following table provides release information about the feature or features described in this module. This table lists only the software release that introduced support for a given feature in a given software release train. Unless noted otherwise, subsequent releases of that software release train also support that feature.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to . An account on Cisco.com is not required.

Table 15: Feature Information for IP SLAs ICMP Echo Operations

Feature Name	Releases	Feature Information
IP SLAs ICMP Echo Operation	Cisco IOS XE Release 3.2SE	The Cisco IOS IP SLAs Internet Control Message Protocol (ICMP) echo operation allows you to measure end-to-end network response time between a Cisco device and other devices using IP. In Cisco IOS XE Release 3.2SE, this feature was supported on the following platforms: • Catalyst 3650 Series Switches • Catalyst 3850 Series Switches • Cisco 5760 Wireless LAN Controller
IPv6 - IP SLAs (UDP Jitter, UDP Echo, ICMP Echo, TCP Connect)	Cisco IOS XE Release 3.2SE	Support was added for operability in IPv6 networks. In Cisco IOS XE Release 3.2SE, this feature was supported on the following platforms: • Catalyst 3650 Series Switches • Catalyst 3850 Series Switches • Cisco 5760 Wireless LAN Controller



CHAPTER 9

Configuring IP SLAs ICMP Path Echo Operations

This module describes how to configure an IP Service Level Agreements (SLAs) Internet Control Message Protocol (ICMP) Path Echo operation to monitor end-to-end and hop-by-hop response time between a Cisco device and other devices using IP. ICMP Path Echo is useful for determining network availability and for troubleshooting network connectivity issues. The results of the ICMP Path Echo operation can be displayed and analyzed to determine how ICMP is performing.

Finding Feature Information

Your software release may not support all the features documented in this module. For the latest caveats and feature information, see Bug Search Tool and the release notes for your platform and software release. To find information about the features documented in this module, and to see a list of the releases in which each feature is supported, see the feature information table.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to www.cisco.com/go/cfn. An account on Cisco.com is not required.

Restrictions for IP SLAs ICMP Path Echo Operations

We recommend using a Cisco networking device as the destination device although any networking device that supports RFC 862, Echo protocol, can be used.

Information About IP SLAs ICMP Path Echo Operations

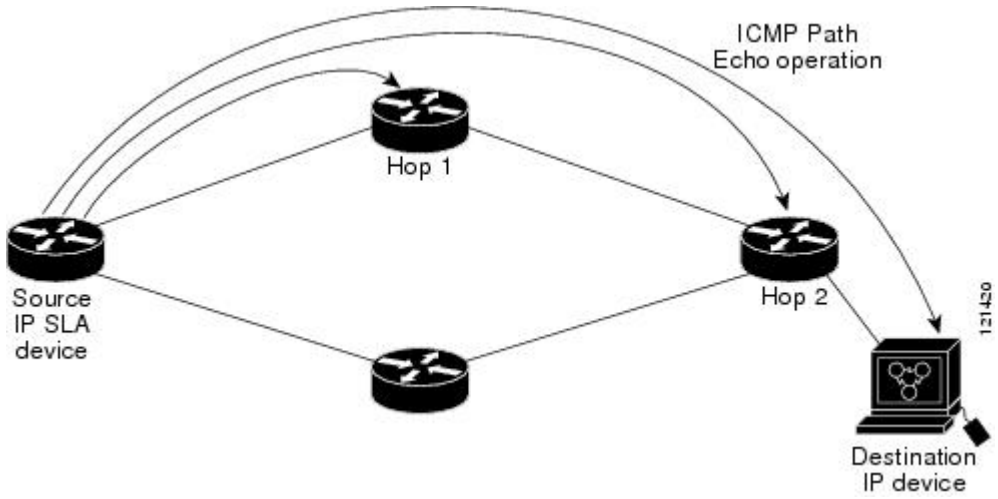
ICMP Path Echo Operation

To monitor ICMP Path Echo performance on a device, use the IP SLAs ICMP Path Echo operation. An ICMP Path Echo operation measures end-to-end and hop-by-hop response time between a Cisco device and other devices using IP. ICMP Path Echo is useful for determining network availability and for troubleshooting network connectivity issues.

The IP SLAs ICMP Path Echo operation records statistics for each hop along the path that the IP SLAs operation takes to reach its destination. The ICMP Path Echo operation determines this hop-by-hop response time between a Cisco device and any IP device on the network by discovering the path using the traceroute facility.

In the figure below the source IP SLAs device uses traceroute to discover the path to the destination IP device. A ping is then used to measure the response time between the source IP SLAs device and each subsequent hop in the path to the destination IP device.

Figure 8: ICMP Path Echo Operation



Using the statistics recorded for the response times and availability, the ICMP Path Echo operation can identify a hop in the path that is causing a bottleneck.

How to Configure IP SLAs ICMP Path Echo Operations

Configuring an ICMP Path Echo Operation on the Source Device

Note This operation does not require an IP SLAs Responder on the destination device.

Perform only one of the following tasks:

Configuring a Basic ICMP Path Echo Operation on the Source Device

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **ip sla** *operation-id*
4. **path-echo** {*destination-ip-address* | *destination-hostname*} [**source-ip** {*ip-address* | *hostname*}]
5. **frequency** *seconds*
6. **end**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Device> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Device# configure terminal`	Enters global configuration mode.
Step 3	**ip sla** *operation-id* **Example:** `Device(config)# ip sla 7`	Specifies an ID number for the operation being configured, and enters IP SLA configuration mode.
Step 4	**path-echo** {*destination-ip-address* | *destination-hostname*} [**source-ip** {*ip-address* | *hostname*}]	Defines a Path Echo operation and enters IP SLA Path Echo configuration mode.

	Command or Action	Purpose
	Example: `Device(config-ip-sla)# path-echo 172.29.139.134`	
Step 5	**frequency** *seconds* **Example:** `Device(config-ip-sla-pathEcho)# frequency 30`	(Optional) Sets the rate at which a specified IP SLAs operation repeats.
Step 6	**end** **Example:** `Device(config-ip-sla-pathEcho)# end`	Exits to privileged EXEC mode.

Example

The following example shows the configuration of the IP SLAs ICMP Path Echo operation number 7 that will start in 30 seconds and run for 5 minutes.

```
ip sla 7
 path-echo 172.29.139.134
 frequency 30
!
ip sla schedule 7 start-time after 00:00:30 life 300
```

Configuring an ICMP Path Echo Operation with Optional Parameters on the Source Device

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **ip sla** *operation-number*
4. **path-echo** {*destination-ip-address* | *destination-hostname*} [**source-ip** {*ip-address* | *hostname*}]
5. **history buckets-kept** *size*
6. **history distributions-of-statistics-kept** *size*
7. **history filter** {**none** | **all** | **overThreshold** | **failures**}
8. **frequency** *seconds*
9. **history hours-of-statistics-kept** *hours*
10. **history lives-kept** *lives*
11. **owner** *owner-id*
12. **paths-of-statistics-kept** *size*
13. **request-data-size** *bytes*
14. **samples-of-history-kept** *samples*
15. **history statistics-distribution-interval** *milliseconds*
16. **tag** *text*
17. **threshold** *milliseconds*
18. **timeout** *milliseconds*
19. **tos** *number*
20. **verify-data**
21. **vrf** *vrf-name*
22. **end**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Device> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Device# configure terminal`	Enters global configuration mode.

	Command or Action	Purpose
Step 3	**ip sla** *operation-number* **Example:** `Device(config)# ip sla 10`	Begins configuration for an IP SLAs operation and enters IP SLA configuration mode.
Step 4	**path-echo** {*destination-ip-address* | *destination-hostname*} [**source-ip** {*ip-address* | *hostname*}] **Example:** `Device(config-ip-sla)# path-echo 172.29.139.134`	Defines a Path Echo operation and enters IP SLA Path Echo configuration mode.
Step 5	**history buckets-kept** *size* **Example:** `Device(config-ip-sla-pathEcho)# history buckets-kept 25`	(Optional) Sets the number of history buckets that are kept during the lifetime of an IP SLAs operation.
Step 6	**history distributions-of-statistics-kept** *size* **Example:** `Device(config-ip-sla-pathEcho)# history distributions-of-statistics-kept 5`	(Optional) Sets the number of statistics distributions kept per hop during an IP SLAs operation.
Step 7	**history filter** {**none** | **all** | **overThreshold** | **failures**} **Example:** `Device(config-ip-sla-pathEcho)# history filter failures`	(Optional) Defines the type of information kept in the history table for an IP SLAs operation.
Step 8	**frequency** *seconds* **Example:** `Device(config-ip-sla-pathEcho)# frequency 30`	(Optional) Sets the rate at which a specified IP SLAs operation repeats.
Step 9	**history hours-of-statistics-kept** *hours* **Example:** `Device(config-ip-sla-pathEcho)# history hours-of-statistics-kept 4`	(Optional) Sets the number of hours for which statistics are maintained for an IP SLAs operation.

	Command or Action	Purpose
Step 10	**history lives-kept** *lives* **Example:** `Device(config-ip-sla-pathEcho)# history lives-kept 5`	(Optional) Sets the number of lives maintained in the history table for an IP SLAs operation.
Step 11	**owner** *owner-id* **Example:** `Device(config-ip-sla-pathEcho)# owner admin`	(Optional) Configures the Simple Network Management Protocol (SNMP) owner of an IP SLAs operation.
Step 12	**paths-of-statistics-kept** *size* **Example:** `Device(config-ip-sla-pathEcho)# paths-of-statistics-kept 3`	(Optional) Sets the number of paths for which statistics are maintained per hour for an IP SLAs operation.
Step 13	**request-data-size** *bytes* **Example:** `Device(config-ip-sla-pathEcho)# request-data-size 64`	(Optional) Sets the protocol data size in the payload of an IP SLAs operation's request packet.
Step 14	**samples-of-history-kept** *samples* **Example:** `Device(config-ip-sla-pathEcho)# samples-of-history-kept 10`	(Optional) Sets the number of entries kept in the history table per bucket for an IP SLAs operation.
Step 15	**history statistics-distribution-interval** *milliseconds* **Example:** `Device(config-ip-sla-pathEcho)# history statistics-distribution-interval 10`	(Optional) Sets the time interval for each statistics distribution kept for an IP SLAs operation.
Step 16	**tag** *text* **Example:** `Device(config-ip-sla-pathEcho)# tag TelnetPollServer1`	(Optional) Creates a user-specified identifier for an IP SLAs operation.
Step 17	**threshold** *milliseconds* **Example:** `Device(config-ip-sla-pathEcho)# threshold 10000`	(Optional) Sets the upper threshold value for calculating network monitoring statistics created by an IP SLAs operation.

	Command or Action	Purpose
Step 18	**timeout** *milliseconds* **Example:** `Device(config-ip-sla-pathEcho)# timeout 10000`	(Optional) Sets the amount of time an IP SLAs operation waits for a response from its request packet.
Step 19	**tos** *number* **Example:** `Device(config-ip-sla-pathEcho)# tos 160`	(Optional) Defines a type of service (ToS) byte in the IP header of an IP SLAs operation.
Step 20	**verify-data** **Example:** `Device(config-ip-sla-pathEcho)# verify-data`	(Optional) Causes an IP SLAs operation to check each reply packet for data corruption.
Step 21	**vrf** *vrf-name* **Example:** `Device(config-ip-sla-pathEcho)# vrf vpn-A`	(Optional) Allows monitoring within Multiprotocol Label Switching (MPLS) Virtual Private Networks (VPNs) using IP SLAs operations.
Step 22	**end** **Example:** `Device(config-ip-sla-pathEcho)# end`	Exits to privileged EXEC mode.

Scheduling IP SLAs Operations

Before You Begin

- All IP Service Level Agreements (SLAs) operations to be scheduled must be already configured.
- The frequency of all operations scheduled in a multioperation group must be the same.
- The list of one or more operation ID numbers to be added to a multioperation group must be limited to a maximum of 125 characters in length, including commas (,).

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. Enter one of the following commands:
   - **ip sla schedule** *operation-number* [**life** {**forever** | *seconds*}] [**start-time** {[*hh*:*mm*:*ss*] [*month day* | *day month*] | **pending** | **now** | **after** *hh*:*mm*:*ss*}] [**ageout** *seconds*] [**recurring**]
   - **ip sla group schedule** *group-operation-number operation-id-numbers* {**schedule-period** *schedule-period-range* | **schedule-together**} [**ageout** *seconds*] [**frequency** *group-operation-frequency*] [**life** {**forever** | *seconds*}] [**start-time** {*hh*:*mm* [:*ss*] [*month day* | *day month*] | **pending** | **now** | **after** *hh*:*mm* [:*ss*]}]
4. **end**
5. **show ip sla group schedule**
6. **show ip sla configuration**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Device> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Device# configure terminal`	Enters global configuration mode.
Step 3	Enter one of the following commands: • **ip sla schedule** *operation-number* [**life** {**forever**	*seconds*}] [**start-time** {[*hh*:*mm*:*ss*] [*month day*	*day month*]	**pending**	**now**	**after** *hh*:*mm*:*ss*}] [**ageout** *seconds*] [**recurring**] • **ip sla group schedule** *group-operation-number operation-id-numbers* {**schedule-period** *schedule-period-range*	**schedule-together**} [**ageout** *seconds*] [**frequency** *group-operation-frequency*] [**life** {**forever**	*seconds*}] [**start-time** {*hh*:*mm* [:*ss*] [*month day*	*day month*]	**pending**	**now**	**after** *hh*:*mm* [:*ss*]}]	• Configures the scheduling parameters for an individual IP SLAs operation. • Specifies an IP SLAs operation group number and the range of operation numbers for a multioperation scheduler.

	Command or Action	Purpose

	Example:
	`Device(config)# ip sla schedule 10 life forever start-time now`
	`Device(config)# ip sla group schedule 10 schedule-period frequency`
	`Device(config)# ip sla group schedule 1 3,4,6-9 life forever start-time now`
	`Device(config)# ip sla schedule 1 3,4,6-9 schedule-period 50 frequency range 80-100`	

Step 4	**end** **Example:** `Device(config)# end`	Exits global configuration mode and returns to privileged EXEC mode.
Step 5	**show ip sla group schedule** **Example:** `Device# show ip sla group schedule`	(Optional) Displays IP SLAs group schedule details.
Step 6	**show ip sla configuration** **Example:** `Device# show ip sla configuration`	(Optional) Displays IP SLAs configuration details.

Troubleshooting Tips

- If the IP Service Level Agreements (SLAs) operation is not running and not generating statistics, add the **verify-data** command to the configuration (while configuring in IP SLA configuration mode) to enable data verification. When data verification is enabled, each operation response is checked for corruption. Use the **verify-data** command with caution during normal operations because it generates unnecessary overhead.
- Use the **debug ip sla trace** and **debug ip sla error** commands to help troubleshoot issues with an IP SLAs operation.

What to Do Next

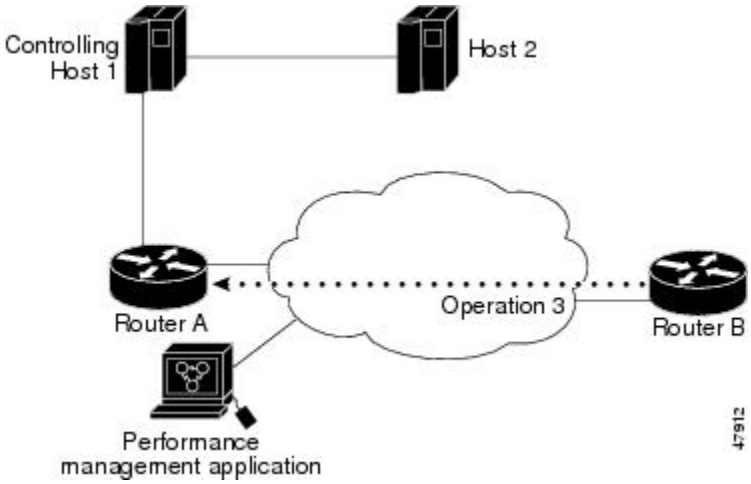
To add proactive threshold conditions and reactive triggering for generating traps (or for starting another operation) to an IP Service Level Agreements (SLAs) operation, see the "Configuring Proactive Threshold Monitoring" section.

Configuration Examples for IP SLAs ICMP Path Echo Operations

Example Configuring an ICMP Path Echo Operation

The following example shows how to configure an IP SLAs operation type of ICMP Path Echo that will start after 30 seconds and run for 5 minutes. The figure below depicts the ICMP Path Echo operation.

Figure 9: ICMP Path Echo Operation



This example sets a Path Echo operation (ip sla 3) from Device B to Device A using IP/ICMP. The operation attempts to execute three times in 25 seconds (first attempt at 0 seconds).

Device B Configuration

```
ip sla 3
 path-echo 172.29.139.134
 frequency 10
 tag SGN-RO
 timeout 1000
ip sla schedule 3 life 25
```

Additional References for IP SLAs ICMP Echo Operations

Related Documents

Related Topic	Document Title
Cisco IOS commands	Cisco IOS Master Commands List, All Releases
IP SLAs commands	Cisco IOS IP SLAs Command Reference
Information about Cisco IP SLAs	"Cisco IOS IP SLAs Overview" module of the *IP SLAs Configuration Guide*

Standards and RFCs

Standard/RFC	Title
RFC 862	Echo Protocol

MIBs

MIBs	MIBs Link
CISCO-RTTMON-MIB	To locate and download MIBs for selected platforms, Cisco IOS releases, and feature sets, use Cisco MIB Locator found at the following URL: http://www.cisco.com/go/mibs

Technical Assistance

Description	Link
The Cisco Support and Documentation website provides online resources to download documentation, software, and tools. Use these resources to install and configure the software and to troubleshoot and resolve technical issues with Cisco products and technologies. Access to most tools on the Cisco Support and Documentation website requires a Cisco.com user ID and password.	http://www.cisco.com/cisco/web/support/index.html

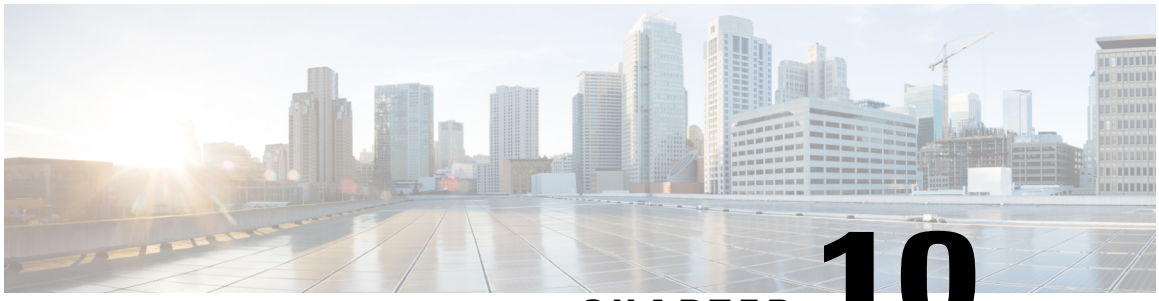
Feature Information for IP SLAs - ICMP Path Echo Operation

The following table provides release information about the feature or features described in this module. This table lists only the software release that introduced support for a given feature in a given software release train. Unless noted otherwise, subsequent releases of that software release train also support that feature.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to . An account on Cisco.com is not required.

Table 16: Feature Information for IP SLAs- ICMP Path Echo Operation

Feature Name	Releases	Feature Information
IP SLAs- ICMP Path Echo Operation	Cisco IOS XE Release 3.2SE	The Cisco IOS IP SLAs Internet Control Message Protocol (ICMP) path echo operation allows you to measure end-to-end and hop-by-hop network response time between a Cisco device and other devices using IP. In Cisco IOS XE Release 3.2SE, this feature was supported on the following platforms: • Catalyst 3650 Series Switches • Catalyst 3850 Series Switches • Cisco 5760 Wireless LAN Controller



CHAPTER 10

Configuring IP SLAs ICMP Path Jitter Operations

This document describes how to configure an IP Service Level Agreements (SLAs) Internet Control Message Protocol (ICMP) Path Jitter operation to monitor hop-by-hop jitter (inter-packet delay variance). This document also demonstrates how the data gathered using the Path Jitter operations can be displayed and analyzed using Cisco commands.

Finding Feature Information

Your software release may not support all the features documented in this module. For the latest caveats and feature information, see Bug Search Tool and the release notes for your platform and software release. To find information about the features documented in this module, and to see a list of the releases in which each feature is supported, see the feature information table.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to www.cisco.com/go/cfn. An account on Cisco.com is not required.

Prerequisites for ICMP Path Jitter Operations

- Before configuring any IP SLAs application, you can use the **show ip sla application** command to verify that the operation type is supported on your software image.

- In contrast with other IP SLAs operations, the IP SLAs Responder does not have to be enabled on either the target device or intermediate devices for Path Jitter operations. However, the operational efficiency may improve if you enable the IP SLAs Responder.

Restrictions for ICMP Path Jitter Operations

- IP SLAs - ICMP Path Jitter is ICMP-based. ICMP-based operations can compensate for source processing delay but cannot compensate for target processing delay. For more robust monitoring and verifying, we recommend that you use the IP SLAs UDP Jitter operation.
- The jitter values obtained using IP SLAs - ICMP Path Jitter are approximates because ICMP does not provide the capability to embed processing times on devices in the packet. If the target device does not place ICMP packets as the highest priority, then the device will not respond properly. ICMP performance also can be affected by the configuration of priority queueing on the device and by ping response.
- A path jitter operation does not support hourly statistics and hop information.
- Unlike other IP SLAs operations, the ICMP Path Jitter operation is not supported in the RTTMON MIB. Path jitter operations can only be configured using Cisco commands and statistics can only be returned using the **show ip sla** commands.
- IP SLAs - Path Jitter does not support the IP SLAs History feature (statistics history buckets) because of the large data volume involved with jitter operations.
- The following commands, available in path jitter configuration mode, do not apply to path jitter operations:
  - **history buckets-kept**
  - **history distributions-of-statistics-kept**
  - **history enhanced**
  - **history filter**
  - **history hours-of-statistics-kept**
  - **history lives-kept**
  - **history statistics-distribution-interval**
  - **samples-of-history-kept**
  - **lsr-path**
  - **tos**
  - **threshold**
  - **verify-data**

Information About IP SLAs ICMP Path Jitter Operations

ICMP Path Jitter Operation

IP SLAs - ICMP Path Jitter provides hop-by-hop jitter, packet loss, and delay measurement statistics in an IP network. Path jitter operations function differently than the standard UDP Jitter operation, which provides total one-way data and total round-trip data.

An ICMP Path Jitter operation can be used a supplement to the standard UDP Jitter operation. For example, results from a UDP Jitter operation may indicate unexpected delays or high jitter values; an ICMP Path Jitter operation could then be used to troubleshoot the network path and determine if traffic is bottlenecking in a particular segment along the transmission path.

The operation first discovers the hop-by-hop IP route from the source to the destination using a traceroute utility, and then uses ICMP echoes to determine the response times, packet loss and approximate jitter values for each hop along the path. The jitter values obtained using IP SLAs - ICMP Path Jitter are approximates because ICMP only provides round trip times.

ICMP Path Jitter operations function by tracing the IP path from a source device to a specified destination device, then sending *N* number of Echo probes to each hop along the traced path, with a time interval of *T* milliseconds between each Echo probe. The operation as a whole is repeated at a frequency of once every *F* seconds. The attributes are user-configurable, as shown here:

Path Jitter Operation Parameter	Default	Configured Using:
Number of echo probes (*N*)	10 echos	**path-jitter** command, **num-packets** option
Time between Echo probes, in milliseconds (*T*)	20 ms	**path-jitter** command, **interval** option **Note** The operation's frequency is different than the operation's interval.
The frequency of how often the operation is repeated (*F*)	once every 60 seconds	**frequency** command

How to Configure the IP SLAs ICMP Path Jitter Operation

Configuring the IP SLAs Responder on a Destination Device

Note An IP SLAs Responder is not required on either the target device or intermediate devices for path jitter operations. However, operational efficiency may improve if you enable the IP SLAs Responder.

Before You Begin

The networking device to be used as the responder must be a Cisco device and you must have connectivity to that device through the network.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **ip sla responder**
4. **exit**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Device> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Device# configure terminal`	Enters global configuration mode.
Step 3	**ip sla responder** **Example:** **Example:** `Device(config)# ip sla responder`	(Optional) Temporarily enables IP SLAs Responder functionality on a Cisco device in response to control messages from source. • Control is enabled by default.
Step 4	**exit** **Example:** `Device(config)# exit`	(Optional) Exits global configuration mode and returns to privileged EXEC mode.

Configuring an ICMP Path Jitter Operation on the Source Device

Perform only one of the following procedures in this section:

Configuring a Basic ICMP Path Jitter Operation

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **ip sla** *operation-number*
4. **path-jitter** {*destination-ip-address* | *destination-hostname*} [**source-ip** {*ip-address* | *hostname*}] [**num-packets** *packet-number*] [**interval** *milliseconds*] [**targetOnly**]
5. **frequency** *seconds*
6. **end**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Device> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Device# configure terminal`	Enters global configuration mode.
Step 3	**ip sla** *operation-number* **Example:** `Device(config)# ip sla 10`	Begins configuration for an IP SLAs operation and enters IP SLA configuration mode.
Step 4	**path-jitter** {*destination-ip-address* | *destination-hostname*} [**source-ip** {*ip-address* | *hostname*}] [**num-packets** *packet-number*] [**interval** *milliseconds*] [**targetOnly**] **Example:** `Device(config-ip-sla)# path-jitter 172.31.1.129 source-ip 10.2.30.1 num-packets 12 interval 22`	Enters IP SLA Path Jitter configuration mode for configuring an ICMP Path Jitter operation.
Step 5	**frequency** *seconds* **Example:** `Device(config-ip-sla-pathJitter)# frequency 30`	(Optional) Sets the rate at which a specified IP SLAs operation repeats.

	Command or Action	Purpose
Step 6	**end** **Example:** `Device(config-ip-sla-pathJitter)# end`	Exits to privileged EXEC mode.

Example

In the following example, the **targetOnly** keyword is used to bypass the hop-by-hop measurements. With this version of the command, echo probes will be sent to the destination only.

```
Device(config)# ip sla 1
Device(config-ip-sla)# path-jitter 172.17.246.20 num-packets 50 interval 30 targetOnly
```

Configuring an ICMP Path Jitter Operation with Additional Parameters

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **ip sla** *operation-number*
4. **path-jitter** {*destination-ip-address* | *destination-hostname*} [**source-ip** {*ip-address* | *hostname*}] [**num-packets** *packet-number*] [**interval** *milliseconds*] [**targetOnly**]
5. **frequency** *seconds*
6. **owner** *owner-id*
7. **request-data-size** *bytes*
8. **tag** *text*
9. **timeout** *milliseconds*
10. **vrf** *vrf-name*
11. **end**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Device> enable`	Enables privileged EXEC mode. • Enter your password if prompted.

	Command or Action	Purpose
Step 2	**configure terminal** **Example:** `Device# configure terminal`	Enters global configuration mode.
Step 3	**ip sla** *operation-number* **Example:** `Device(config)# ip sla 10`	Begins configuration for an IP SLAs operation and enters IP SLA configuration mode.
Step 4	**path-jitter** {*destination-ip-address* | *destination-hostname*} [**source-ip** {*ip-address* | *hostname*}] [**num-packets** *packet-number*] [**interval** *milliseconds*] [**targetOnly**] **Example:** `Device(config-ip-sla)# path-jitter 172.31.1.129 source-ip 10.2.30.1 num-packets 12 interval 22`	Enters IP SLA Path Jitter configuration mode for defing an ICMP Path Jitter operation.
Step 5	**frequency** *seconds* **Example:** `Device(config-ip-sla-pathJitter)# frequency 30`	(Optional) Sets the rate at which a specified IP SLAs operation repeats.
Step 6	**owner** *owner-id* **Example:** `Device(config-ip-sla-pathJitter)# owner admin`	(Optional) Configures the Simple Network Management Protocol (SNMP) owner of an IP SLAs operation.
Step 7	**request-data-size** *bytes* **Example:** `Device(config-ip-sla-pathJitter)# request-data-size 64`	(Optional) Sets the protocol data size in the payload of an IP SLAs operation's request packet.
Step 8	**tag** *text* **Example:** `Device(config-ip-sla-pathJitter)# tag TelnetPollServer1`	(Optional) Creates a user-specified identifier for an IP SLAs operation.

	Command or Action	Purpose
Step 9	**timeout** *milliseconds* **Example:** `Device(config-ip-sla-pathJitter)# timeout 10000`	(Optional) Sets the amount of time an IP SLAs operation waits for a response from its request packet.
Step 10	**vrf** *vrf-name* **Example:** `Device(config-ip-sla-pathJitter)# vrf vpn-A`	(Optional) Allows monitoring within Multiprotocol Label Switching (MPLS) Virtual Private Networks (VPNs) using IP SLAs operations.
Step 11	**end** **Example:** `Device(config-ip-sla-pathJitter)# end`	Exits to privileged EXEC mode.

Scheduling IP SLAs Operations

Before You Begin

- All IP Service Level Agreements (SLAs) operations to be scheduled must be already configured.
- The frequency of all operations scheduled in a multioperation group must be the same.
- The list of one or more operation ID numbers to be added to a multioperation group must be limited to a maximum of 125 characters in length, including commas (,).

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. Enter one of the following commands:
   - **ip sla schedule** *operation-number* [**life** {**forever** | *seconds*}] [**start-time** {[*hh*:*mm*:*ss*] [*month day* | *day month*] | **pending** | **now** | **after** *hh*:*mm*:*ss*}] [**ageout** *seconds*] [**recurring**]
   - **ip sla group schedule** *group-operation-number operation-id-numbers* {**schedule-period** *schedule-period-range* | **schedule-together**} [**ageout** *seconds*] [**frequency** *group-operation-frequency*] [**life** {**forever** | *seconds*}] [**start-time** {*hh*:*mm* [:*ss*] [*month day* | *day month*] | **pending** | **now** | **after** *hh*:*mm* [:*ss*]}]
4. **end**
5. **show ip sla group schedule**
6. **show ip sla configuration**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Device> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Device# configure terminal`	Enters global configuration mode.
Step 3	Enter one of the following commands: • **ip sla schedule** *operation-number* [**life** {**forever**	*seconds*}] [**start-time** {[*hh*:*mm*:*ss*] [*month day*	*day month*]	**pending**	**now**	**after** *hh*:*mm*:*ss*}] [**ageout** *seconds*] [**recurring**] • **ip sla group schedule** *group-operation-number operation-id-numbers* {**schedule-period** *schedule-period-range*	**schedule-together**} [**ageout** *seconds*] [**frequency** *group-operation-frequency*] [**life** {**forever**	*seconds*}] [**start-time** {*hh*:*mm* [:*ss*] [*month day*	*day month*]	**pending**	**now**	**after** *hh*:*mm* [:*ss*]}]	• Configures the scheduling parameters for an individual IP SLAs operation. • Specifies an IP SLAs operation group number and the range of operation numbers for a multioperation scheduler.

	Command or Action	Purpose

	Example:
	`Device(config)# ip sla schedule 10 life forever start-time now`
	`Device(config)# ip sla group schedule 10 schedule-period frequency`
	`Device(config)# ip sla group schedule 1 3,4,6-9 life forever start-time now`
	`Device(config)# ip sla schedule 1 3,4,6-9 schedule-period 50 frequency range 80-100`	

Step 4	**end** **Example:** `Device(config)# end`	Exits global configuration mode and returns to privileged EXEC mode.
Step 5	**show ip sla group schedule** **Example:** `Device# show ip sla group schedule`	(Optional) Displays IP SLAs group schedule details.
Step 6	**show ip sla configuration** **Example:** `Device# show ip sla configuration`	(Optional) Displays IP SLAs configuration details.

Troubleshooting Tips

- If the IP Service Level Agreements (SLAs) operation is not running and not generating statistics, add the **verify-data** command to the configuration (while configuring in IP SLA configuration mode) to enable data verification. When data verification is enabled, each operation response is checked for corruption. Use the **verify-data** command with caution during normal operations because it generates unnecessary overhead.
- Use the **debug ip sla trace** and **debug ip sla error** commands to help troubleshoot issues with an IP SLAs operation.

What to Do Next

To add proactive threshold conditions and reactive triggering for generating traps (or for starting another operation) to an IP Service Level Agreements (SLAs) operation, see the “Configuring Proactive Threshold Monitoring” section.

Configuration Examples for IP SLAs ICMP Path Jitter Operations

Example Configuring a Path Jitter Operation

The following example shows the output when the ICMP Path Jitter operation is configured. Because the path jitter operation does not support hourly statistics and hop information, the output for the **show ip sla statistics** command for the path jitter operation displays only the statistics for the first hop.

The following example shows the output when the ICMP Path Jitter operation is configured.

```
Device# configure terminal
Device(config)# ip sla 15011
Device(config-sla-monitor)# path-jitter 10.222.1.100 source-ip 10.222.3.100 num-packets 20
Device(config-sla-monitor-pathJitter)# frequency 30
Device(config-sla-monitor-pathJitter)# exit
Device(config)# ip sla schedule 15011 life forever start-time now
Device(config)# exit
Device# show ip sla statistics 15011
Round Trip Time (RTT) for       Index 15011
        Latest RTT: 1 milliseconds
Latest operation start time: 15:37:35.443 EDT Mon Jun 16 2008
Latest operation return code: OK
---- Path Jitter Statistics ----
Hop IP 10.222.3.252:
Round Trip Time milliseconds:
        Latest RTT: 1 ms
        Number of RTT: 20
        RTT Min/Avg/Max: 1/1/3 ms
Jitter time milliseconds:
        Number of jitter: 2
        Jitter Min/Avg/Max: 2/2/2 ms
Packet Values:
        Packet Loss (Timeouts): 0
        Out of Sequence: 0
        Discarded Samples: 0
Operation time to live: Forever
```

Additional References

Related Documents

Related Topic	Document Title
Cisco IOS commands	Cisco IOS Master Commands List, All Releases
Cisco IOS IP SLAs commands	Cisco IOS IP SLAs Command Reference

Standards and RFCs

Standard/RFC	Title
RFC 1889[4]	*RTP: A Transport Protocol for Real-Time Applications* ; see the section "Estimating the Interarrival Jitter"

4 Support for the listed RFC is not claimed; listed as a reference only.

MIBs

MIBs	MIBs Link
MIB support for the Path Jitter operation is not provided.	To locate and download MIBs for selected platforms, Cisco IOS releases, and feature sets, use Cisco MIB Locator found at the following URL: http://www.cisco.com/go/mibs

Technical Assistance

Description	Link
The Cisco Support and Documentation website provides online resources to download documentation, software, and tools. Use these resources to install and configure the software and to troubleshoot and resolve technical issues with Cisco products and technologies. Access to most tools on the Cisco Support and Documentation website requires a Cisco.com user ID and password.	http://www.cisco.com/cisco/web/support/index.html

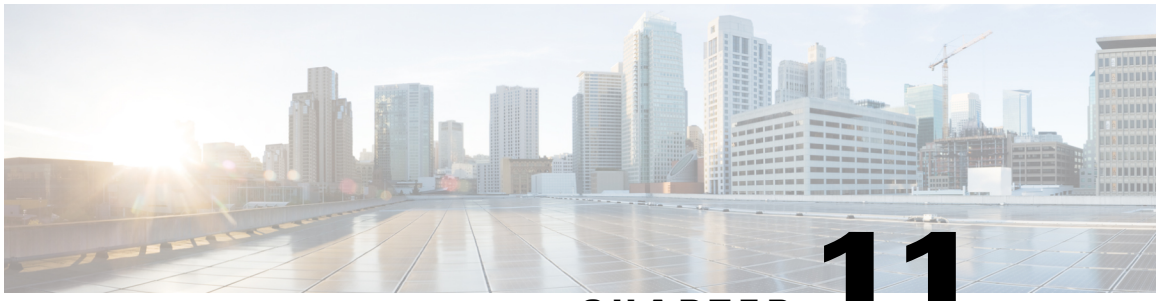
Feature Information for IP SLAs ICMP Path Jitter Operations

The following table provides release information about the feature or features described in this module. This table lists only the software release that introduced support for a given feature in a given software release train. Unless noted otherwise, subsequent releases of that software release train also support that feature.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to . An account on Cisco.com is not required.

Table 17: Feature Information for IP SLAs ICMP Path Jitter Operations

Feature Name	Releases	Feature Information
IP SLAs Path Jitter Operation	Cisco IOS XE Release 3.2SE	The Cisco IOS IP SLAs Internet Control Message Protocol (ICMP) path jitter operation allows you to measure hop-by-hop jitter (inter-packet delay variance). In Cisco IOS XE Release 3.2SE, this feature was supported on the following platforms: • Catalyst 3650 Series Switches • Catalyst 3850 Series Switches • Cisco 5760 Wireless LAN Controller
IPSLA 4.0 - IP v6 phase2	Cisco IOS XE Release 3.2SE	Support was added for operability in IPv6 networks. In Cisco IOS XE Release 3.2SE, this feature was supported on the following platforms: • Catalyst 3650 Series Switches • Catalyst 3850 Series Switches • Cisco 5760 Wireless LAN Controller The following commands are introduced or modified: **path-jitter**, **show ip sla configuration**, **show ip sla summary**.



CHAPTER 11

Configuring IP SLAs FTP Operations

This module describes how to configure an IP Service Level Agreements (SLAs) File Transfer Protocol (FTP) operation to measure the response time between a Cisco device and an FTP server to retrieve a file. The IP SLAs FTP operation supports an FTP GET request only. This module also demonstrates how the results of the FTP operation can be displayed and analyzed to determine the capacity of your network. The FTP operation can be used also for troubleshooting FTP server performance.

Finding Feature Information

Your software release may not support all the features documented in this module. For the latest caveats and feature information, see Bug Search Tool and the release notes for your platform and software release. To find information about the features documented in this module, and to see a list of the releases in which each feature is supported, see the feature information table.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to www.cisco.com/go/cfn. An account on Cisco.com is not required.

Restrictions for IP SLAs FTP Operations

The IP SLAs FTP operation only supports FTP GET (download) requests.

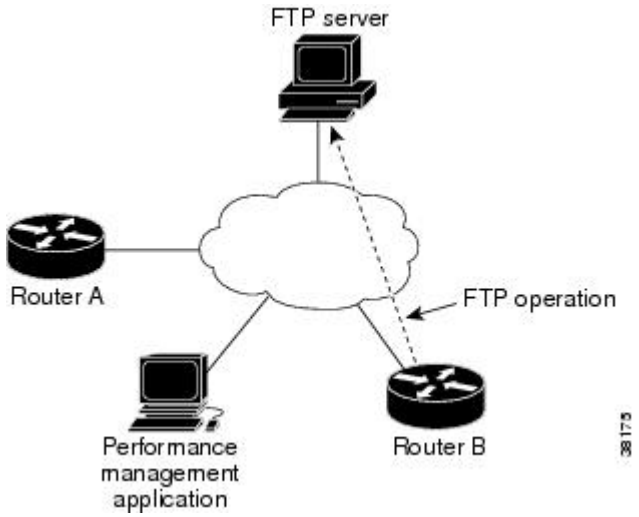
Information About IP SLAs FTP Operations

FTP Operation

The FTP operation measures the round-trip time (RTT) between a Cisco device and an FTP server to retrieve a file. FTP is an application protocol, part of the Transmission Control Protocol (TCP)/IP protocol stack, used for transferring files between network nodes.

In the figure below Device B is configured as the source IP SLAs device and an FTP operation is configured with the FTP server as the destination device.

Figure 10: FTP Operation



Connection response time is computed by measuring the time taken to download a file to Device B from the remote FTP server using FTP over TCP. This operation does not use the IP SLAs Responder.

Note To test the response time to connect to an FTP port (Port 21), use the IP SLAs TCP Connect operation.

Both active and passive FTP transfer modes are supported. The passive mode is enabled by default. Only the FTP GET (download) operation type is supported. The URL specified for the FTP GET operation must be in one of the following formats:

- ftp://username:password@host/filename
- ftp://host/filename

If the username and password are not specified, the defaults are anonymous and test, respectively.

FTP carries a significant amount of data traffic and can affect the performance of your network. The results of an IP SLAs FTP operation to retrieve a large file can be used to determine the capacity of the network but retrieve large files with caution because the FTP operation will consume more bandwidth. The FTP operation also measures your FTP server performance levels by determining the RTT taken to retrieve a file.

How to Configure IP SLAs FTP Operations

Configuring an FTP Operation on a Source Device

Note There is no need to configure an IP SLAs responder on the destination device.

Perform one of the following tasks:

Configuring a Basic FTP Operation on the Source Device

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **ip sla** *operation-number*
4. **ftp get** *url* [**source-ip** {*ip-address* | *hostname*}] [**mode** {**passive** | **active**}
5. **frequency** *seconds*
6. **end**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Device> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Device# configure terminal`	Enters global configuration mode.
Step 3	**ip sla** *operation-number* **Example:** `Device(config)# ip sla 10`	Begins configuration for an IP SLAs operation and enters IP SLA configuration mode.

	Command or Action	Purpose
Step 4	**ftp get** *url* [**source-ip** {*ip-address* | *hostname*}] [**mode** {**passive** | **active**} **Example:** `Device(config-ip-sla)# ftp get ftp://username:password@hostip/test.cap`	Defines an FTP operation and enters IP SLA FTP configuration mode.
Step 5	**frequency** *seconds* **Example:** `Device(config-ip-sla-ftp)# frequency 30`	(Optional) Sets the rate at which a specified IP SLAs operation repeats.
Step 6	**end** **Example:** `Device(config-ip-sla-ftp)# exit`	Exits to privileged EXEC mode.

Configuring an FTP Operation with Optional Parameters on the Source Device

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **ip sla** *operation-number*
4. **ftp get** *url* [**source-ip** {*ip-address* | *hostname*}] [**mode** {**passive** | **active**}
5. **history buckets-kept** *size*
6. **history distributions-of-statistics-kept** *size*
7. **history enhanced** [**interval** *seconds*] [**buckets** *number-of-buckets*]
8. **history filter** {**none** | **all** | **overThreshold** | **failures**}
9. **frequency** *seconds*
10. **history hours-of-statistics-kept** *hours*
11. **history lives-kept** *lives*
12. **owner** *owner-id*
13. **history statistics-distribution-interval** *milliseconds*
14. **tag** *text*
15. **threshold** *milliseconds*
16. **timeout** *milliseconds*
17. **end**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Device> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Device# configure terminal`	Enters global configuration mode.
Step 3	**ip sla** *operation-number* **Example:** `Device(config)# ip sla 10`	Begins configuration for an IP SLAs operation and enters IP SLA configuration mode.
Step 4	**ftp get** *url* [**source-ip** {*ip-address* | *hostname*}] [**mode** {**passive** | **active**} **Example:** `Device(config-ip-sla)# ftp get ftp://username:password@hostip/filename`	Defines an FTP operation and enters IP SLA FTP configuration mode.
Step 5	**history buckets-kept** *size* **Example:** `Device(config-ip-sla-ftp)# history buckets-kept 25`	(Optional) Sets the number of history buckets that are kept during the lifetime of an IP SLAs operation.
Step 6	**history distributions-of-statistics-kept** *size* **Example:** `Device(config-ip-sla-ftp)# history distributions-of-statistics-kept 5`	(Optional) Sets the number of statistics distributions kept per hop during an IP SLAs operation.
Step 7	**history enhanced** [**interval** *seconds*] [**buckets** *number-of-buckets*] **Example:** `Device(config-ip-sla-ftp)# history enhanced interval 900 buckets 100`	(Optional) Enables enhanced history gathering for an IP SLAs operation.

	Command or Action	Purpose
Step 8	**history filter** {**none** | **all** | **overThreshold** | **failures**} **Example:** `Device(config-ip-sla-ftp)# history filter failures`	(Optional) Defines the type of information kept in the history table for an IP SLAs operation.
Step 9	**frequency** *seconds* **Example:** `Device(config-ip-sla-ftp)# frequency 30`	(Optional) Sets the rate at which a specified IP SLAs operation repeats.
Step 10	**history hours-of-statistics-kept** *hours* **Example:** `Device(config-ip-sla-ftp)# history hours-of-statistics-kept 4`	(Optional) Sets the number of hours for which statistics are maintained for an IP SLAs operation.
Step 11	**history lives-kept** *lives* **Example:** `Device(config-ip-sla-ftp)# history lives-kept 5`	(Optional) Sets the number of lives maintained in the history table for an IP SLAs operation.
Step 12	**owner** *owner-id* **Example:** `Device(config-ip-sla-ftp)# owner admin`	(Optional) Configures the Simple Network Management Protocol (SNMP) owner of an IP SLAs operation.
Step 13	**history statistics-distribution-interval** *milliseconds* **Example:** `Device(config-ip-sla-ftp)# history statistics-distribution-interval 10`	(Optional) Sets the time interval for each statistics distribution kept for an IP SLAs operation.
Step 14	**tag** *text* **Example:** `Device(config-ip-sla-ftp)# tag TelnetPollServer1`	(Optional) Creates a user-specified identifier for an IP SLAs operation.
Step 15	**threshold** *milliseconds* **Example:** `Device(config-ip-sla-ftp)# threshold 10000`	(Optional) Sets the upper threshold value for calculating network monitoring statistics created by an IP SLAs operation.

	Command or Action	Purpose
Step 16	**timeout** *milliseconds* **Example:** `Device(config-ip-sla-ftp)# timeout 10000`	(Optional) Sets the amount of time an IP SLAs operation waits for a response from its request packet.
Step 17	**end** **Example:** `Device(config-ip-sla-ftp)# end`	Exits to privileged EXEC mode.

Scheduling IP SLAs Operations

Before You Begin

- All IP Service Level Agreements (SLAs) operations to be scheduled must be already configured.
- The frequency of all operations scheduled in a multioperation group must be the same.
- The list of one or more operation ID numbers to be added to a multioperation group must be limited to a maximum of 125 characters in length, including commas (,).

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. Enter one of the following commands:
   - **ip sla schedule** *operation-number* [**life** {**forever** | *seconds*}] [**start-time** {[*hh*:*mm*:*ss*] [*month day* | *day month*] | **pending** | **now** | **after** *hh*:*mm*:*ss*}] [**ageout** *seconds*] [**recurring**]
   - **ip sla group schedule** *group-operation-number operation-id-numbers* {**schedule-period** *schedule-period-range* | **schedule-together**} [**ageout** *seconds*] [**frequency** *group-operation-frequency*] [**life** {**forever** | *seconds*}] [**start-time** {*hh*:*mm* [:*ss*] [*month day* | *day month*] | **pending** | **now** | **after** *hh*:*mm* [:*ss*]}]
4. **end**
5. **show ip sla group schedule**
6. **show ip sla configuration**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Device> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Device# configure terminal`	Enters global configuration mode.

Step 3	Enter one of the following commands:
	• **ip sla schedule** *operation-number* [**life** {**forever** | *seconds*}] [**start-time** {[*hh*:*mm*:*ss*] [*month day* | *day month*] | **pending** | **now** | **after** *hh*:*mm*:*ss*}] [**ageout** *seconds*] [**recurring**]
	• **ip sla group schedule** *group-operation-number operation-id-numbers* {**schedule-period** *schedule-period-range* | **schedule-together**} [**ageout** *seconds*] [**frequency** *group-operation-frequency*] [**life** {**forever** | *seconds*}] [**start-time** {*hh*:*mm* [:*ss*] [*month day* | *day month*] | **pending** | **now** | **after** *hh*:*mm* [:*ss*]}]
	
	Example:
	`Device(config)# ip sla schedule 10 life forever start-time now`
	`Device(config)# ip sla group schedule 10 schedule-period frequency`
	`Device(config)# ip sla group schedule 1 3,4,6-9 life forever start-time now`
	`Device(config)# ip sla schedule 1 3,4,6-9 schedule-period 50 frequency range 80-100`
		• Configures the scheduling parameters for an individual IP SLAs operation.
		• Specifies an IP SLAs operation group number and the range of operation numbers for a multioperation scheduler.

Step 4	**end** **Example:** `Device(config)# end`	Exits global configuration mode and returns to privileged EXEC mode.
Step 5	**show ip sla group schedule** **Example:** `Device# show ip sla group schedule`	(Optional) Displays IP SLAs group schedule details.

	Command or Action	Purpose
Step 6	**show ip sla configuration** **Example:** `Device# show ip sla configuration`	(Optional) Displays IP SLAs configuration details.

Troubleshooting Tips

- If the IP Service Level Agreements (SLAs) operation is not running and not generating statistics, add the **verify-data** command to the configuration (while configuring in IP SLA configuration mode) to enable data verification. When data verification is enabled, each operation response is checked for corruption. Use the **verify-data** command with caution during normal operations because it generates unnecessary overhead.
- Use the **debug ip sla trace** and **debug ip sla error** commands to help troubleshoot issues with an IP SLAs operation.

What to Do Next

To add proactive threshold conditions and reactive triggering for generating traps (or for starting another operation) to an IP Service Level Agreements (SLAs) operation, see the “Configuring Proactive Threshold Monitoring” section.

Configuration Examples for IP SLAs FTP Operations

Example: Configuring an FTP Operation

The following example shows how to configure an FTP operation from Device B to the FTP server as shown in the "FTP Operation" figure in the "Information About IP SLAs FTP Operation" section. The operation is scheduled to start every day at 1:30 a.m. In this example, the file named test.cap is to be retrieved from the host, cisco.com, with a password of abc using FTP in active mode.

Device B Configuration

```
ip sla 10
 ftp get ftp://user1:abc@test.cisco.com/test.cap mode active
 frequency 20
 tos 128
 timeout 40000
 tag FLL-FTP
ip sla schedule 10 start-time 01:30:00 recurring
```

Additional References

Related Documents

Related Topic	Document Title
Cisco IOS commands	Cisco IOS Master Commands List, All Releases
Cisco IOS IP SLAs commands	Cisco IOS IP SLAs Command Reference

MIBs

MIBs	MIBs Link
CISCO-RTTMON-MIB	To locate and download MIBs for selected platforms, Cisco IOS releases, and feature sets, use Cisco MIB Locator found at the following URL: http://www.cisco.com/go/mibs

Technical Assistance

Description	Link
The Cisco Support and Documentation website provides online resources to download documentation, software, and tools. Use these resources to install and configure the software and to troubleshoot and resolve technical issues with Cisco products and technologies. Access to most tools on the Cisco Support and Documentation website requires a Cisco.com user ID and password.	http://www.cisco.com/cisco/web/support/index.html

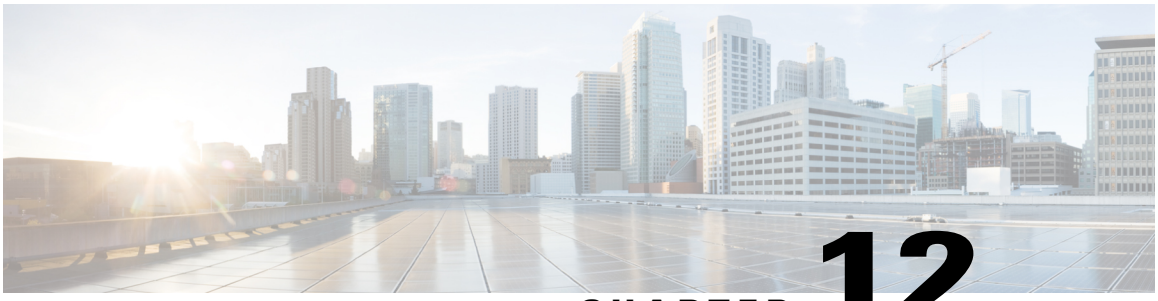
Feature Information for IP SLAs - FTP Operation

The following table provides release information about the feature or features described in this module. This table lists only the software release that introduced support for a given feature in a given software release train. Unless noted otherwise, subsequent releases of that software release train also support that feature.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to . An account on Cisco.com is not required.

Table 18: Feature Information for the IP SLAs - FTP Operation

Feature Name	Releases	Feature Information
IP SLAs - FTP Operation	Cisco IOS XE Release 3.2SE	The IP SLAs File Transfer Protocol (FTP) operation allows you to measure the network response time between a Cisco device and an FTP server to retrieve a file. In Cisco IOS XE Release 3.2SE, this feature was supported on the following platforms: • Catalyst 3650 Series Switches • Catalyst 3850 Series Switches • Cisco 5760 Wireless LAN Controller



CHAPTER 12

Configuring IP SLAs DNS Operations

This module describes how to configure the IP Service Level Agreements (SLAs) Domain Name System (DNS) operation to measure the difference between the time taken to send a DNS request and receive a reply. This module also demonstrates how the results of the DNS operation can be displayed and analyzed to determine the DNS lookup time which is a critical element for determining the performance of a DNS or web server.

Finding Feature Information

Your software release may not support all the features documented in this module. For the latest caveats and feature information, see Bug Search Tool and the release notes for your platform and software release. To find information about the features documented in this module, and to see a list of the releases in which each feature is supported, see the feature information table.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to www.cisco.com/go/cfn. An account on Cisco.com is not required.

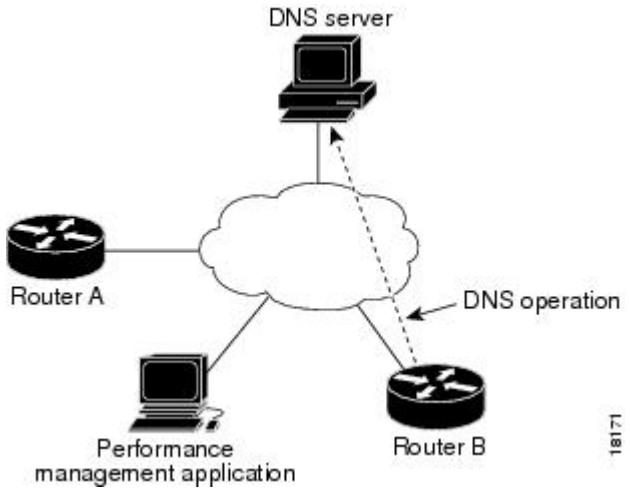
Information About IP SLAs DNS Operations

DNS Operation

The DNS operation measures the difference between the time taken to send a DNS request and receive a reply. DNS is used in the Internet for translating names of network nodes into addresses. The IP SLAs DNS operation queries for an IP address if you specify a host name, or queries for a host name if you specify an IP address.

In the figure below Device B is configured as the source IP SLAs device and a DNS operation is configured with the DNS server as the destination device.

Figure 11: DNS Operation



Connection response time is computed by measuring the difference between the time taken to send a request to the DNS server and the time a reply is received by Device B. The resulting DNS lookup time can help you analyze your DNS performance. Faster DNS lookup times translate to a faster web server access experience.

How to Configure IP SLAs DNS Operations

Configuring an IP SLAs DNS Operation on the Source Device

Note There is no need to configure an IP SLAs responder on the destination device.

Perform one of the following tasks:

Configuring a Basic DNS Operation on the Source Device

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **ip sla** *operation-number*
4. **dns** {*destination-ip-address* | *destination-hostname*} **name-server** *ip-address* [**source-ip** {*ip-address* | *hostname*} **source-port** *port-number*]
5. **frequency** *seconds*
6. **end**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Device> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Device# configure terminal`	Enters global configuration mode.
Step 3	**ip sla** *operation-number* **Example:** `Device(config)# ip sla 10`	Begins configuration for an IP SLAs operation and enters IP SLA configuration mode.
Step 4	**dns** {*destination-ip-address* | *destination-hostname*} **name-server** *ip-address* [**source-ip** {*ip-address* | *hostname*} **source-port** *port-number*] **Example:** `Device(config-ip-sla)# dns host1 name-server 172.20.2.132`	Defines a DNS operation and enters IP SLA DNS configuration mode.
Step 5	**frequency** *seconds* **Example:** `Device(config-ip-sla-dns)# frequency 60`	(Optional) Sets the rate at which a specified IP SLAs operation repeats.

	Command or Action	Purpose
Step 6	**end** **Example:** `Device(config-ip-sla-dns)# end`	Exits to privileged EXEC mode.

Configuring a DNS Operation with Optional Parameters on the Source Device

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **ip sla** *operation-number*
4. **dns** {*destination-ip-address* | *destination-hostname*} **name-server** *ip-address* [**source-ip** {*ip-address* | *hostname*} **source-port** *port-number*]
5. **history buckets-kept** *size*
6. **history distributions-of-statistics-kept** *size*
7. **history enhanced** [**interval** *seconds*] [**buckets** *number-of-buckets*]
8. **history filter** {**none** | **all** | **overThreshold** | **failures**}
9. **frequency** *seconds*
10. **history hours-of-statistics-kept** *hours*
11. **history lives-kept** *lives*
12. **owner** *owner-id*
13. **history statistics-distribution-interval** *milliseconds*
14. **tag** *text*
15. **threshold** *milliseconds*
16. **timeout** *milliseconds*
17. **end**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Device> enable`	Enables privileged EXEC mode. • Enter your password if prompted.

	Command or Action	Purpose
Step 2	**configure terminal** **Example:** `Device# configure terminal`	Enters global configuration mode.
Step 3	**ip sla** *operation-number* **Example:** `Device(config)# ip sla 10`	Begins configuration for an IP SLAs operation and enters IP SLA configuration mode.
Step 4	**dns** {*destination-ip-address* | *destination-hostname*} **name-server** *ip-address* [**source-ip** {*ip-address* | *hostname*} **source-port** *port-number*] **Example:** `Device(config-ip-sla)# dns host1 name-server 172.20.2.132`	Defines a DNS operation and enters IP SLA DNS configuration mode.
Step 5	**history buckets-kept** *size* **Example:** `Device(config-ip-sla-dns)# history buckets-kept 25`	(Optional) Sets the number of history buckets that are kept during the lifetime of an IP SLAs operation.
Step 6	**history distributions-of-statistics-kept** *size* **Example:** `Device(config-ip-sla-dns)# history distributions-of-statistics-kept 5`	(Optional) Sets the number of statistics distributions kept per hop during an IP SLAs operation.
Step 7	**history enhanced** [**interval** *seconds*] [**buckets** *number-of-buckets*] **Example:** `Device(config-ip-sla-dns)# history enhanced interval 900 buckets 100`	(Optional) Enables enhanced history gathering for an IP SLAs operation.
Step 8	**history filter** {**none** | **all** | **overThreshold** | **failures**} **Example:** `Device(config-ip-sla-dns)# history filter failures`	(Optional) Defines the type of information kept in the history table for an IP SLAs operation.

	Command or Action	Purpose
Step 9	**frequency** *seconds* **Example:** `Device(config-ip-sla-dns)# frequency 30`	(Optional) Sets the rate at which a specified IP SLAs operation repeats.
Step 10	**history hours-of-statistics-kept** *hours* **Example:** `Device(config-ip-sla-dns)# history hours-of-statistics-kept 4`	(Optional) Sets the number of hours for which statistics are maintained for an IP SLAs operation.
Step 11	**history lives-kept** *lives* **Example:** `Device(config-ip-sla-dns)# history lives-kept 5`	(Optional) Sets the number of lives maintained in the history table for an IP SLAs operation.
Step 12	**owner** *owner-id* **Example:** `Device(config-ip-sla-dns)# owner admin`	(Optional) Configures the Simple Network Management Protocol (SNMP) owner of an IP SLAs operation.
Step 13	**history statistics-distribution-interval** *milliseconds* **Example:** `Device(config-ip-sla-dns)# history statistics-distribution-interval 10`	(Optional) Sets the time interval for each statistics distribution kept for an IP SLAs operation.
Step 14	**tag** *text* **Example:** `Device(config-ip-sla-dns)# tag TelnetPollServer1`	(Optional) Creates a user-specified identifier for an IP SLAs operation.
Step 15	**threshold** *milliseconds* **Example:** `Device(config-ip-sla-dns)# threshold 10000`	(Optional) Sets the upper threshold value for calculating network monitoring statistics created by an IP SLAs operation.
Step 16	**timeout** *milliseconds* **Example:** `Device(config-ip-sla-dns)# timeout 10000`	(Optional) Sets the amount of time an IP SLAs operation waits for a response from its request packet.

	Command or Action	Purpose
Step 17	**end** **Example:** `Device(config-ip-sla-dns)# end`	Exits to privileged EXEC mode.

Scheduling IP SLAs Operations

Before You Begin

- All IP Service Level Agreements (SLAs) operations to be scheduled must be already configured.
- The frequency of all operations scheduled in a multioperation group must be the same.
- The list of one or more operation ID numbers to be added to a multioperation group must be limited to a maximum of 125 characters in length, including commas (,).

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. Enter one of the following commands:
   - **ip sla schedule** *operation-number* [**life** {**forever** | *seconds*}] [**start-time** {[*hh*:*mm*:*ss*] [*month day* | *day month*] | **pending** | **now** | **after** *hh*:*mm*:*ss*}] [**ageout** *seconds*] [**recurring**]
   - **ip sla group schedule** *group-operation-number operation-id-numbers* {**schedule-period** *schedule-period-range* | **schedule-together**} [**ageout** *seconds*] [**frequency** *group-operation-frequency*] [**life** {**forever** | *seconds*}] [**start-time** {*hh*:*mm* [:*ss*] [*month day* | *day month*] | **pending** | **now** | **after** *hh*:*mm* [:*ss*]}]
4. **end**
5. **show ip sla group schedule**
6. **show ip sla configuration**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Device> enable`	Enables privileged EXEC mode. • Enter your password if prompted.

	Command or Action	Purpose
Step 2	**configure terminal** **Example:** `Device# configure terminal`	Enters global configuration mode.

Step 3	Enter one of the following commands:
	• **ip sla schedule** *operation-number* [**life** {**forever** | *seconds*}] [**start-time** {[*hh*:*mm*:*ss*] [*month day* | *day month*] | **pending** | **now** | **after** *hh*:*mm*:*ss*}] [**ageout** *seconds*] [**recurring**]
	• **ip sla group schedule** *group-operation-number operation-id-numbers* {**schedule-period** *schedule-period-range* | **schedule-together**} [**ageout** *seconds*] [**frequency** *group-operation-frequency*] [**life** {**forever** | *seconds*}] [**start-time** {*hh*:*mm* [:*ss*] [*month day* | *day month*] | **pending** | **now** | **after** *hh*:*mm* [:*ss*]}]
	
	Example:
	`Device(config)# ip sla schedule 10 life forever start-time now`
	`Device(config)# ip sla group schedule 10 schedule-period frequency`
	`Device(config)# ip sla group schedule 1 3,4,6-9 life forever start-time now`
	`Device(config)# ip sla schedule 1 3,4,6-9 schedule-period 50 frequency range 80-100`
		• Configures the scheduling parameters for an individual IP SLAs operation.
		• Specifies an IP SLAs operation group number and the range of operation numbers for a multioperation scheduler.

Step 4	**end** **Example:** `Device(config)# end`	Exits global configuration mode and returns to privileged EXEC mode.
Step 5	**show ip sla group schedule** **Example:** `Device# show ip sla group schedule`	(Optional) Displays IP SLAs group schedule details.
Step 6	**show ip sla configuration** **Example:** `Device# show ip sla configuration`	(Optional) Displays IP SLAs configuration details.

Troubleshooting Tips

- If the IP Service Level Agreements (SLAs) operation is not running and not generating statistics, add the **verify-data** command to the configuration (while configuring in IP SLA configuration mode) to enable data verification. When data verification is enabled, each operation response is checked for corruption. Use the **verify-data** command with caution during normal operations because it generates unnecessary overhead.
- Use the **debug ip sla trace** and **debug ip sla error** commands to help troubleshoot issues with an IP SLAs operation.

What to Do Next

To add proactive threshold conditions and reactive triggering for generating traps (or for starting another operation) to an IP Service Level Agreements (SLAs) operation, see the "Configuring Proactive Threshold Monitoring" section.

Configuration Examples for IP SLAs DNS Operations

Example Configuring a DNS Operation

The following example shows how to configure a DNS operation from Device B to the DNS server (IP address 172.20.2.132) as shown in the "DNS Operation" figure in the "DNS Operation" section. The operation is scheduled to start immediately. In this example, the target address is a hostname and the DNS operation will query the DNS server for the IP address associated with the hostname host1. No configuration is required at the DNS server.

Device B Configuration

```
ip sla 11
 dns host1 name-server 172.20.2.132
 frequency 50
 timeout 8000
 tag DNS-Test
ip sla schedule 11 start-time now
```

Additional References

Related Documents

Related Topic	Document Title
Cisco IOS commands	Cisco IOS Master Commands List, All Releases
Cisco IOS IP SLAs commands	Cisco IOS IP SLAs Command Reference, All Releases

Related Topic	Document Title
Cisco IOS IP SLAs: general information	"Cisco IOS IP SLAs Overview" module of the *Cisco IOS IP SLAs Configuration Guide*.
Multioperation scheduling for IP SLAs	"Configuring Multioperation Scheduling of IP SLAs Operations" module of the *Cisco IOS P SLAs Configuration Guide*
Proactive threshold monitoring for IP SLAs	"Configuring Proactive Threshold Monitoring of IP SLAs Operations" module of the *Cisco IOS IP SLAs Configuration Guide*

MIBs

MIBs	MIBs Link
CISCO-RTTMON-MIB	To locate and download MIBs for selected platforms, Cisco IOS releases, and feature sets, use Cisco MIB Locator found at the following URL: http://www.cisco.com/go/mibs

Technical Assistance

Description	Link
The Cisco Support and Documentation website provides online resources to download documentation, software, and tools. Use these resources to install and configure the software and to troubleshoot and resolve technical issues with Cisco products and technologies. Access to most tools on the Cisco Support and Documentation website requires a Cisco.com user ID and password.	http://www.cisco.com/cisco/web/support/index.html

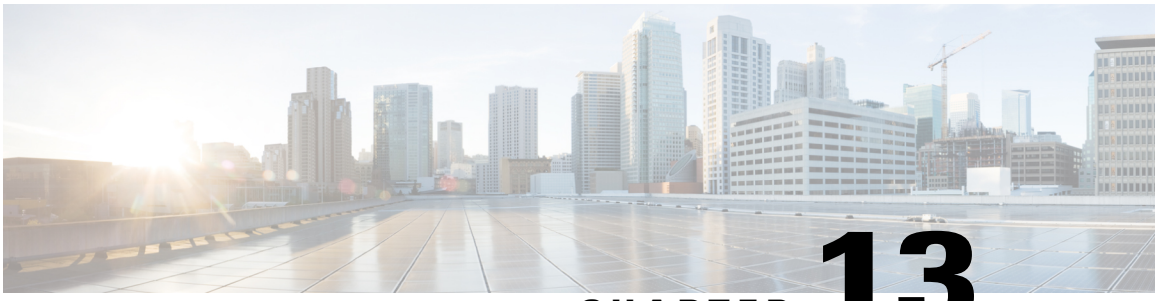
Feature Information for IP SLAs - DNS Operation

The following table provides release information about the feature or features described in this module. This table lists only the software release that introduced support for a given feature in a given software release train. Unless noted otherwise, subsequent releases of that software release train also support that feature.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to . An account on Cisco.com is not required.

Table 19: Feature Information for the IP SLAs - DNS Operation

Feature Name	Releases	Feature Information
IP SLAs - DNS Operation	Cisco IOS XE Release 3.2SE	The IP SLAs Domain Name System (DNS) Operation feature allows you to measure the difference between the time taken to send a DNS request and receive a reply. In Cisco IOS XE Release 3.2SE, this feature was supported on the following platforms: • Catalyst 3650 Series Switches • Catalyst 3850 Series Switches • Cisco 5760 Wireless LAN Controller



CHAPTER 13

Configuring IP SLAs DHCP Operations

This module describes how to configure an IP Service Level Agreements (SLAs) Dynamic Host Control Protocol (DHCP) probe to measure the response time between a Cisco device and a DHCP server to obtain an IP address.

Finding Feature Information

Your software release may not support all the features documented in this module. For the latest caveats and feature information, see Bug Search Tool and the release notes for your platform and software release. To find information about the features documented in this module, and to see a list of the releases in which each feature is supported, see the feature information table.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to www.cisco.com/go/cfn. An account on Cisco.com is not required.

Information About IP SLAs DHCP Operations

DHCP Operation

DHCP provides a mechanism for allocating IP addresses dynamically so that addresses can be reused when hosts no longer need them. The DHCP operation measures the round-trip time (RTT) taken to discover a DHCP server and obtain a leased IP address from it. IP SLAs releases the leased IP address after the operation.

You can use the RTT information to determine DHCP performance levels.

There are two modes for the DHCP operation. By default, the DHCP operation sends discovery packets on every available IP interface on the device. If a specific server is configured on the device, discovery packets are sent only to the specified DHCP server.

IP SLAs DHCP Relay Agent Options

A DHCP relay agent is any host that forwards DHCP packets between clients and servers. Relay agents are used to forward requests and replies between clients and servers when they are not on the same physical subnet. Relay agent forwarding is distinct from the normal forwarding of an IP device, where IP packets are switched between networks somewhat transparently. Relay agents receive DHCP messages and then generate a new DHCP message to send out on another interface.

The IP SLAs DHCP operation contains a relay agent information option--Option 82, which is inserted by the DHCP relay agent when forwarding client-originated DHCP packets to a DHCP server. Servers recognizing the relay agent information option may use the information to implement IP address or other parameter assignment policies. The DHCP server echoes the option back verbatim to the relay agent in server-to-client replies, and the relay agent strips the option before forwarding the reply to the client.

Option 82 includes three suboptions that convey information known by the relay agent:

- Circuit-id --identifies the incoming circuit.
- Remote-id --provides a trusted identifier for a remote high-speed modem.
- Subnet-mask --identifies the mask of the logical IP subnet from which the relay agent received the client DHCP packet.

How to Configure IP SLAs DHCP Operations

Note There is no need to configure an IP SLAs responder on the destination device.

Configuring a DHCP Operation on the Source Device

Perform one of the following tasks:

Configuring a Basic DHCP Operation

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **ip sla** *operation-number*
4. **dhcp** {*destination-ip-address* | *destination-hostname*} [**source-ip** {*ip-address* | *hostname*}] [**option-82** [**circuit-id** *circuit-id*] [**remote-id** *remote-id*] [**subnet-mask** *subnet-mask*]]
5. **frequency** *seconds*
6. **end**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Device> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Device# configure terminal`	Enters global configuration mode.
Step 3	**ip sla** *operation-number* **Example:** `Device(config)# ip sla 10`	Begins configuration for an IP SLAs operation and enters IP SLA configuration mode.
Step 4	**dhcp** {*destination-ip-address* | *destination-hostname*} [**source-ip** {*ip-address* | *hostname*}] [**option-82** [**circuit-id** *circuit-id*] [**remote-id** *remote-id*] [**subnet-mask** *subnet-mask*]] **Example:** `Device(config-ip-sla)# dhcp 10.10.10.3`	Defines a DHCP operation and enters IP SLA DHCP configuration mode.
Step 5	**frequency** *seconds* **Example:** `Device(config-ip-sla-dhcp)# frequency 30`	(Optional) Sets the rate at which a specified IP SLAs operation repeats.

	Command or Action	Purpose
Step 6	**end** **Example:** `Device(config-ip-sla-dhcp)# end`	Exits to privileged EXEC mode.

Configuring a DHCP Operation with Optional Parameters

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **ip sla** *operation-number*
4. **dhcp** {*destination-ip-address* | *destination-hostname*} [**source-ip** {*ip-address* | *hostname*}] [**option-82** [**circuit-id** *circuit-id*] [**remote-id** *remote-id*] [**subnet-mask** *subnet-mask*]]
5. **history buckets-kept** *size*
6. **history distributions-of-statistics-kept** *size*
7. **history filter** {**none** | **all** | **overThreshold** | **failures**}
8. **frequency** *seconds*
9. **history hours-of-statistics-kept** *hours*
10. **history lives-kept** *lives*
11. **owner** *owner-id*
12. **history statistics-distribution-interval** *milliseconds*
13. **tag** *text*
14. **threshold** *milliseconds*
15. **timeout** *milliseconds*
16. **end**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Device> enable`	Enables privileged EXEC mode. • Enter your password if prompted.

	Command or Action	Purpose
Step 2	**configure terminal** **Example:** `Device# configure terminal`	Enters global configuration mode.
Step 3	**ip sla** *operation-number* **Example:** `Device(config)# ip sla 10`	Begins configuration for an IP SLAs operation and enters IP SLA configuration mode.
Step 4	**dhcp** {*destination-ip-address* | *destination-hostname*} [**source-ip** {*ip-address* | *hostname*}] [**option-82** [**circuit-id** *circuit-id*] [**remote-id** *remote-id*] [**subnet-mask** *subnet-mask*]] **Example:** `Device(config-ip-sla)# dhcp 10.10.10.3 option-82 circuit-id 10005A6F1234`	Defines a DHCP operation and enters IP SLA DHCP configuration mode.
Step 5	**history buckets-kept** *size* **Example:** `Device(config-ip-sla-dhcp)# history buckets-kept 25`	(Optional) Sets the number of history buckets that are kept during the lifetime of an IP SLAs operation.
Step 6	**history distributions-of-statistics-kept** *size* **Example:** `Device(config-ip-sla-dhcp)# history distributions-of-statistics-kept 5`	(Optional) Sets the number of statistics distributions kept per hop during an IP SLAs operation.
Step 7	**history filter** {**none** | **all** | **overThreshold** | **failures**} **Example:** `Device(config-ip-sla-dhcp)# history filter failures`	(Optional) Defines the type of information kept in the history table for an IP SLAs operation.
Step 8	**frequency** *seconds* **Example:** `Device(config-ip-sla-dhcp)# frequency 30`	(Optional) Sets the rate at which a specified IP SLAs operation repeats.

	Command or Action	Purpose
Step 9	**history hours-of-statistics-kept** *hours* **Example:** `Device(config-ip-sla-dhcp)# history hours-of-statistics-kept 4`	(Optional) Sets the number of hours for which statistics are maintained for an IP SLAs operation.
Step 10	**history lives-kept** *lives* **Example:** `Device(config-ip-sla-dhcp)# history lives-kept 5`	(Optional) Sets the number of lives maintained in the history table for an IP SLAs operation.
Step 11	**owner** *owner-id* **Example:** `Device(config-ip-sla-dhcp)# owner admin`	(Optional) Configures the Simple Network Management Protocol (SNMP) owner of an IP SLAs operation.
Step 12	**history statistics-distribution-interval** *milliseconds* **Example:** `Device(config-ip-sla-dhcp)# history statistics-distribution-interval 10`	(Optional) Sets the time interval for each statistics distribution kept for an IP SLAs operation.
Step 13	**tag** *text* **Example:** `Device(config-ip-sla-dhcp)# tag TelnetPollServer1`	(Optional) Creates a user-specified identifier for an IP SLAs operation.
Step 14	**threshold** *milliseconds* **Example:** `Device(config-ip-sla-dhcp)# threshold 10000`	(Optional) Sets the upper threshold value for calculating network monitoring statistics created by an IP SLAs operation.
Step 15	**timeout** *milliseconds* **Example:** `Device(config-ip-sla-dhcp)# timeout 10000`	(Optional) Sets the amount of time an IP SLAs operation waits for a response from its request packet.
Step 16	**end** **Example:** `Device(config-ip-sla-dhcp)# end`	Exits to privileged EXEC mode.

Scheduling IP SLAs Operations

Before You Begin

- All IP Service Level Agreements (SLAs) operations to be scheduled must be already configured.
- The frequency of all operations scheduled in a multioperation group must be the same.
- The list of one or more operation ID numbers to be added to a multioperation group must be limited to a maximum of 125 characters in length, including commas (,).

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. Enter one of the following commands:
   - **ip sla schedule** *operation-number* [**life** {**forever** | *seconds*}] [**start-time** {[*hh*:*mm*:*ss*] [*month day* | *day month*] | **pending** | **now** | **after** *hh*:*mm*:*ss*}] [**ageout** *seconds*] [**recurring**]
   - **ip sla group schedule** *group-operation-number operation-id-numbers* {**schedule-period** *schedule-period-range* | **schedule-together**} [**ageout** *seconds*] [**frequency** *group-operation-frequency*] [**life** {**forever** | *seconds*}] [**start-time** {*hh*:*mm* [:*ss*] [*month day* | *day month*] | **pending** | **now** | **after** *hh*:*mm* [:*ss*]}]
4. **end**
5. **show ip sla group schedule**
6. **show ip sla configuration**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Device> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Device# configure terminal`	Enters global configuration mode.
Step 3	Enter one of the following commands: • **ip sla schedule** *operation-number* [**life** {**forever**	*seconds*}] [**start-time** {[*hh*:*mm*:*ss*] [*month day*	*day month*]	**pending**	**now**	**after** *hh*:*mm*:*ss*}] [**ageout** *seconds*] [**recurring**]	• Configures the scheduling parameters for an individual IP SLAs operation. • Specifies an IP SLAs operation group number and the range of operation numbers for a multioperation scheduler.

	Command or Action	Purpose
	• **ip sla group schedule** *group-operation-number operation-id-numbers* {**schedule-period** *schedule-period-range* | **schedule-together**} [**ageout** *seconds*] [**frequency** *group-operation-frequency*] [**life** {**forever** | *seconds*}] [**start-time** {*hh*:*mm* [:*ss*] [*month day* | *day month*] | **pending** | **now** | **after** *hh*:*mm* [:*ss*]}]	

	Example:
	`Device(config)# ip sla schedule 10 life forever start-time now`
	`Device(config)# ip sla group schedule 10 schedule-period frequency`
	`Device(config)# ip sla group schedule 1 3,4,6-9 life forever start-time now`
	`Device(config)# ip sla schedule 1 3,4,6-9 schedule-period 50 frequency range 80-100`	

Step 4	**end** **Example:** `Device(config)# end`	Exits global configuration mode and returns to privileged EXEC mode.
Step 5	**show ip sla group schedule** **Example:** `Device# show ip sla group schedule`	(Optional) Displays IP SLAs group schedule details.
Step 6	**show ip sla configuration** **Example:** `Device# show ip sla configuration`	(Optional) Displays IP SLAs configuration details.

Troubleshooting Tips

- If the IP Service Level Agreements (SLAs) operation is not running and not generating statistics, add the **verify-data** command to the configuration (while configuring in IP SLA configuration mode) to enable data verification. When data verification is enabled, each operation response is checked for corruption. Use the **verify-data** command with caution during normal operations because it generates unnecessary overhead.

- Use the **debug ip sla trace** and **debug ip sla error** commands to help troubleshoot issues with an IP SLAs operation.

What to Do Next

To add proactive threshold conditions and reactive triggering for generating traps (or for starting another operation) to an IP Service Level Agreements (SLAs) operation, see the "Configuring Proactive Threshold Monitoring" section.

Configuration Examples for IP SLAs DHCP Operations

Example Configuration for an IP SLAs DHCP Operation

In the following example, IP SLAs operation number 12 is configured as a DHCP operation enabled for DHCP server 172.16.20.3. Note that DHCP option 82 is used to specify the circuit ID.

Device B Configuration

```
ip dhcp-server 172.16.20.3
!
ip sla 12
 dhcp 10.10.10.3 option-82 circuit-id 10005A6F1234
 frequency 30
 timeout 5000
 tag DHCP_Test
!
ip sla schedule 12 start-time now
```

Additional References

Related Documents

Related Topic	Document Title
Cisco IOS commands	Cisco IOS Master Commands List, All Releases
Cisco IOS IP SLAs commands	Cisco IOS IP SLAs Command Reference, All Releases
Cisco IOS IP SLAs: general information	"Cisco IOS IP SLAs Overview" module of the *Cisco IOS IP SLAs Configuration Guide*.
Multioperation scheduling for IP SLAs	"Configuring Multioperation Scheduling of IP SLAs Operations" module of the *Cisco IOS P SLAs Configuration Guide*

Related Topic	Document Title
Proactive threshold monitoring for IP SLAs	"Configuring Proactive Threshold Monitoring of IP SLAs Operations" module of the *Cisco IOS IP SLAs Configuration Guide*

MIBs

MIBs	MIBs Link
CISCO-RTTMON-MIB	To locate and download MIBs for selected platforms, Cisco IOS releases, and feature sets, use Cisco MIB Locator found at the following URL: http://www.cisco.com/go/mibs

Technical Assistance

Description	Link
The Cisco Support and Documentation website provides online resources to download documentation, software, and tools. Use these resources to install and configure the software and to troubleshoot and resolve technical issues with Cisco products and technologies. Access to most tools on the Cisco Support and Documentation website requires a Cisco.com user ID and password.	http://www.cisco.com/cisco/web/support/index.html

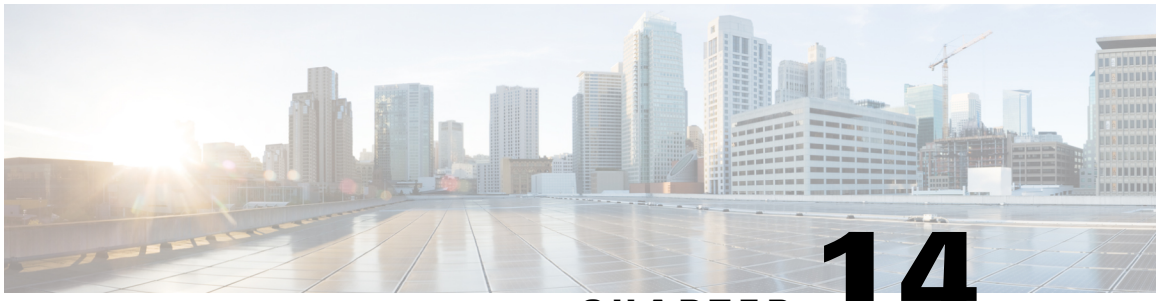
Feature Information for IP SLAs DHCP Operations

The following table provides release information about the feature or features described in this module. This table lists only the software release that introduced support for a given feature in a given software release train. Unless noted otherwise, subsequent releases of that software release train also support that feature.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to . An account on Cisco.com is not required.

Table 20: Feature Information for IP SLAs DHCP Operations

Feature Name	Releases	Feature Information
IP SLAs DHCP Probe	Cisco IOS XE Release 3.2SE	The IP SLAs Dynamic Host Control Protocol (DHCP) Probe feature allows you to schedule and measure the network response time between a Cisco device and a DHCP server to obtain an IP address. In Cisco IOS XE Release 3.2SE, this feature was supported on the following platforms: • Catalyst 3650 Series Switches • Catalyst 3850 Series Switches • Cisco 5760 Wireless LAN Controller



CHAPTER 14

Configuring an IP SLAs Multioperation Scheduler

This document describes how to schedule multiple operations at once using the IP Service Level Agreements (SLAs) Multioperations Scheduler feature.

Finding Feature Information

Your software release may not support all the features documented in this module. For the latest caveats and feature information, see Bug Search Tool and the release notes for your platform and software release. To find information about the features documented in this module, and to see a list of the releases in which each feature is supported, see the feature information table.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to www.cisco.com/go/cfn. An account on Cisco.com is not required.

Restrictions for an IP SLAs Multioperation Scheduler

Do not use the **no ip sla group schedule** and **ip sla group schedule** commands consecutively in a configuration file and copy it into the running configuration. This causes some of the Service Level Agreement (SLA) probes to go down.

Prerequisites for an IP SLAs Multioperation Scheduler

- Configure the IP SLAs operations to be included in a group before scheduling the group.
- Determine the IP SLAs operations you want to schedule as a single group.
- Identify the network traffic type and the location of your network management station.
- Identify the topology and the types of devices in your network.
- Decide on the frequency of testing for each operation.

Information About an IP SLAs Multioperation Scheduler

IP SLAs Multioperations Scheduler

Normal scheduling of IP SLAs operations allows you to schedule one operation at a time. If you have large networks with thousands of IP SLAs operations to monitor network performance, normal scheduling (scheduling each operation individually) will be inefficient and time-consuming.

Multiple operations scheduling allows you to schedule multiple IP SLAs operations using a single command through the command line interface (CLI) or the CISCO-RTTMON-MIB. This feature allows you to control the amount of IP SLAs monitoring traffic by scheduling the operations to run at evenly distributed times. You must specify the operation ID numbers to be scheduled and the time range over which all the IP SLAs operations should start. This feature automatically distributes the IP SLAs operations at equal intervals over a specified time frame. The spacing between the operations (start interval) is calculated and the operations are started. This distribution of IP SLAs operations helps minimize the CPU utilization and thereby enhances the scalability of the network.

The IP SLAs multiple operations scheduling functionality allows you to schedule multiple IP SLAs operations as a group, using the following configuration parameters:

- Group operation number--Group configuration or group schedule number of the IP SLAs operation to be scheduled.
- Operation ID numbers--A list of IP SLAs operation ID numbers in the scheduled operation group.
- Schedule period--Amount of time for which the IP SLAs operation group is scheduled.
- Ageout--Amount of time to keep the operation in memory when it is not actively collecting information. By default, the operation remains in memory indefinitely.
- Frequency--Amount of time after which each IP SLAs operation is restarted. When the frequency option is specified, it overwrites the operation frequency of all operations belonging to the group. Note that when the frequency option is not specified, the frequency for each operation is set to the value of the schedule period.
- Life--Amount of time the operation actively collects information. The operation can be configured to run indefinitely. By default, the lifetime of an operation is one hour.
- Start time--Time when the operation starts collecting information. You can specify an operation to start immediately or at an absolute start time using hours, minutes, seconds, day, and month.

The IP SLAs multiple operations scheduling functionality schedules the maximum number of operations possible without aborting. However, this functionality skips those IP SLAs operations that are already running or those that are not configured and hence do not exist. The total number of operations will be calculated based on the number of operations specified in the command, irrespective of the number of operations that are missing or already running. The IP SLAs multiple operations scheduling functionality displays a message showing the number of active and missing operations. However, these messages are displayed only if you schedule operations that are not configured or are already running.

A main benefit for scheduling multiple IP SLAs operations is that the load on the network is reduced by distributing the operations equally over a scheduled period. This distribution helps you to achieve more consistent monitoring coverage. To illustrate this scenario, consider configuring 60 operations to start during the same 1-second interval over a 60-second schedule period. If a network failure occurs 30 seconds after all 60 operations have started and the network is restored before the operations are due to start again (in another 30 seconds), then this failure would never be detected by any of the 60 operations. However, if the 60 operations are distributed equally at 1-second intervals over a 60-second schedule period, then some of the operations would detect the network failure. Conversely, if a network failure occurs when all 60 operations are active, then all 60 operations would fail, indicating that the failure is possibly more severe than it really is.

Operations of the same type and same frequency should be used for IP SLAs multiple operations scheduling. If you do not specify a frequency, the default frequency will be the same as that of the schedule period. The schedule period is the period of time in which all the specified operations should run.

The following sections focus on the interaction of the schedule period and frequency values, additional values, such as start time and lifetime values, are not included in the illustrations.

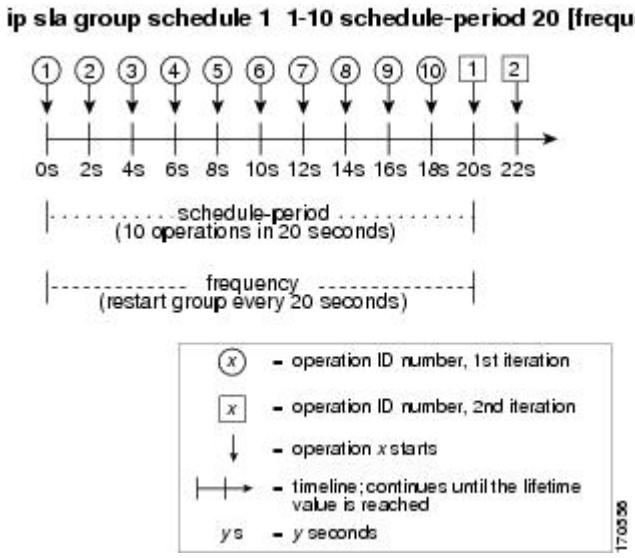
Default Behavior of IP SLAs Multiple Operations Scheduling

The IP SLAs Multiple Operations Scheduling feature allows you to schedule multiple IP SLAs operations as a group.

The figure below illustrates the scheduling of operation group 1 that includes operation 1 to operation 10. Operation group 1 has a schedule period of 20 seconds, which means that all operations in the group will be started at equal intervals within a 20-second period. By default, the frequency is set to the same value as the

configured schedule period. As shown in the figure below, configuring the frequencyis optional because 20 is the default.

Figure 12: Schedule Period Equals Frequency--Default Behavior



In this example, the first operation (operation 1) in operation group 1 will start at 0 seconds. All 10 operations in operation group 1 (operation 1 to operation 10) must be started in the schedule period of 20 seconds. The start time of each IP SLAs operation is evenly distributed over the schedule period by dividing the schedule period by the number of operations (20 seconds divided by 10 operations). Therefore, each operation will start 2 seconds after the previous operation.

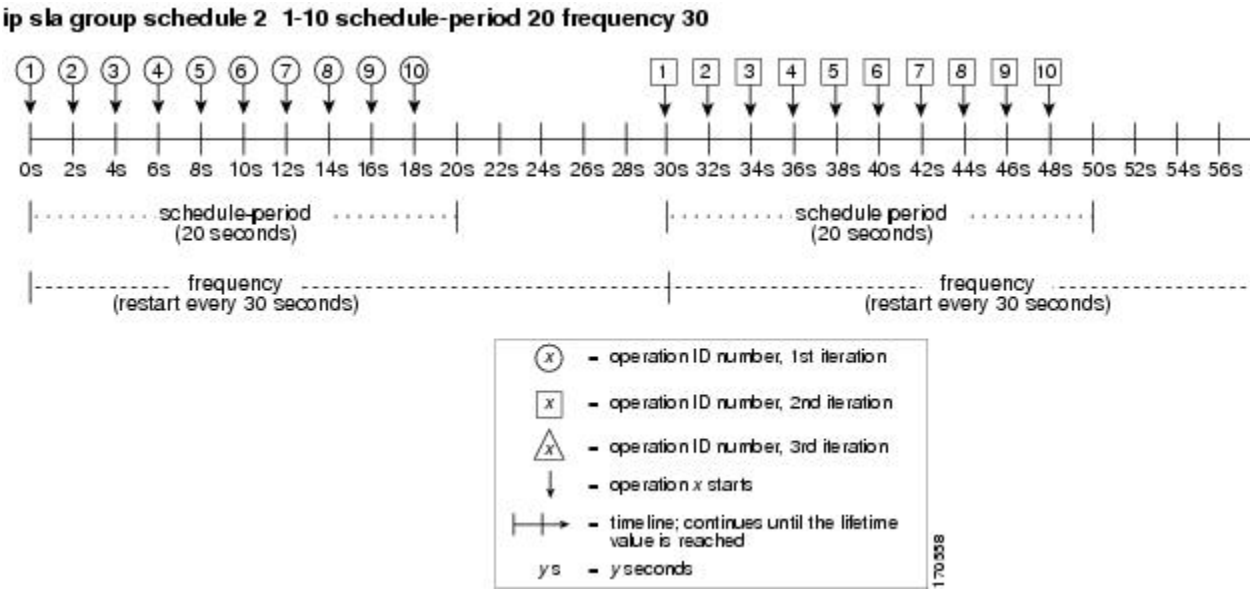
The frequency is the period of time that passes before the operation group is started again (repeated). If the frequency is not specified, the frequency is set to the value of the schedule period. In the example shown above, operation group 1 will start again every 20 seconds. This configuration provides optimal division (spacing) of operations over the specified schedule period.

IP SLAs Multiple Operations Scheduling with Scheduling Period Less Than Frequency

The frequency value is the amount of time that passes before the schedule group is restarted, if the schedule period is less than the frequency, there will be a period of time in which no operations are started.

The figure below illustrates the scheduling of operation 1 to operation 10 within operation group 2. Operation group 2 has a schedule period of 20 seconds and a frequency of 30 seconds.

Figure 13: Schedule Period Is Less Than Frequency



In this example, the first operation (operation 1) in operation group 2 will start at 0 seconds. All 10 operations in operation group 2 (operation 1 to operation 10) must be started in the schedule period of 20 seconds. The start time of each IP SLAs operation is evenly distributed over the schedule period by dividing the schedule period by the number of operations (20 seconds divided by 10 operations). Therefore, each operation will start 2 seconds after the previous operation.

In the first iteration of operation group 2, operation 1 starts at 0 seconds, and the last operation (operation 10) starts at 18 seconds. However, because the group frequency has been configured to 30 seconds each operation in the operation group is restarted every 30 seconds. So, after 18 seconds, there is a gap of 10 seconds as no operations are started in the time from 19 seconds to 29 seconds. Hence, at 30 seconds, the second iteration of operation group 2 starts. As all ten operations in the operation group 2 must start at an evenly distributed interval in the configured schedule period of 20 seconds, the last operation (operation 10) in the operation group 2 will always start 18 seconds after the first operation (operation 1).

As illustrated in the figure above, the following events occur:

- At 0 seconds, the first operation (operation 1) in operation group 2 is started.
- At 18 seconds, the last operation (operation 10) in operation group 2 is started. This means that the first iteration (schedule period) of operation group 1 ends here.
- From 19 to 29 seconds, no operations are started.
- At 30 seconds, the first operation (operation 1) in operation group 2 is started again. The second iteration of operation group 2 starts here.
- At 48 seconds (18 seconds after the second iteration started) the last operation (operation 10) in operation group 2 is started, and the second iteration of operation group 2 ends.
- At 60 seconds, the third iteration of operation group 2 starts.

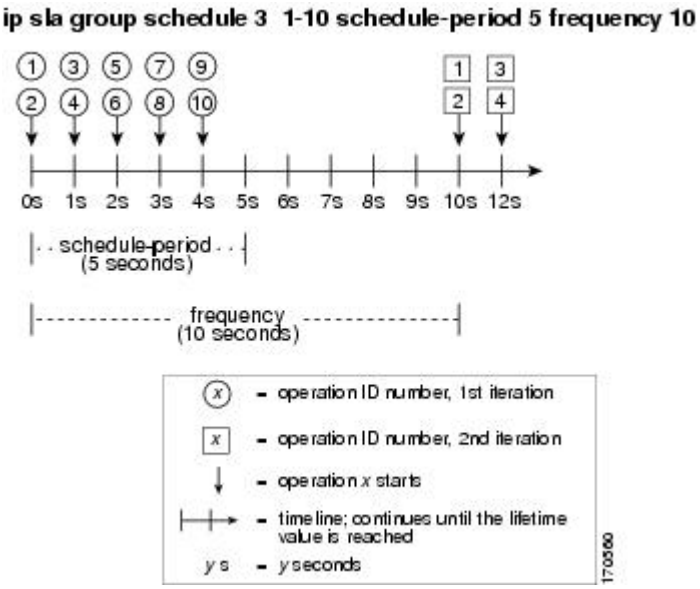
This process continues until the lifetime of operation group 2 ends. The lifetime value is configurable. The default lifetime for an operation group is forever.

Multiple Operations Scheduling When the Number of IP SLAs Operations Are Greater Than the Schedule Period

The minimum time interval between the start of IP SLAs operations in a group operation is 1 second. Therefore, if the number of operations to be multiple scheduled is greater than the schedule period, the IP SLAs multiple operations scheduling functionality will schedule more than one operation to start within the same 1-second interval. If the number of operations getting scheduled does not equally divide into 1-second intervals, then the operations are equally divided at the start of the schedule period with the remaining operations to start at the last 1-second interval.

The figure below illustrates the scheduling of operation 1 to operation 10 within operation group 3. Operation group 3 has a schedule period of 5 seconds and a frequency of 10 seconds.

Figure 14: Number of IP SLAs Operations Is Greater Than the Schedule Period--Even Distribution



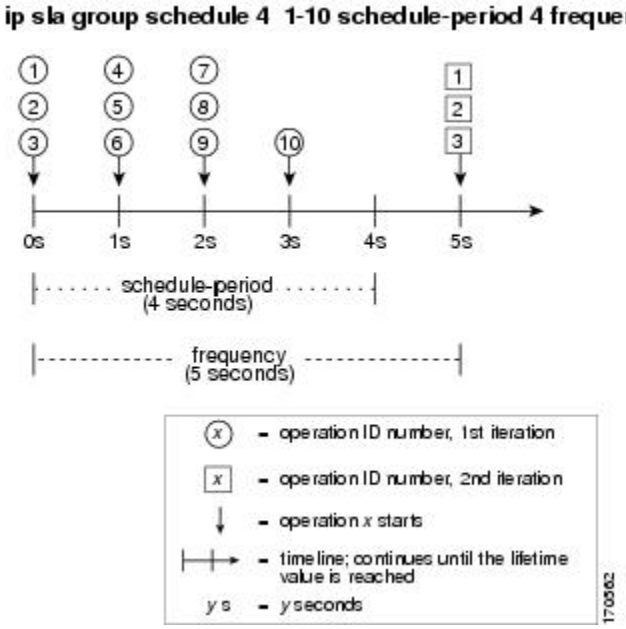
In this example, when dividing the schedule period by the number of operations (5 seconds divided by 10 operations, which equals one operation every 0.5 seconds) the start time of each IP SLAs operation is less than 1 second. Since the minimum time interval between the start of IP SLAs operations in a group operation is 1 second, the IP SLAs multiple operations scheduling functionality instead calculates how many operations it should start in each 1-second interval by dividing the number of operations by the schedule period (10 operations divided by 5 seconds). Therefore, as shown in the figure above, two operations will be started every 1 second.

As the frequency is set to 10 in this example, each iteration of operation group 3 will start 10 seconds after the start of the previous iteration. However, this distribution is not optimal as there is a gap of 5 seconds (frequency minus schedule period) between the cycles.

If the number of operations getting scheduled does not equally divide into 1-second intervals, then the operations are equally divided at the start of the schedule period with the remaining operations to start at the last 1-second interval.

The figure below illustrates the scheduling of operation 1 to operation 10 within operation group 4. Operation group 4 has a schedule period of 4 seconds and a frequency of 5 seconds.

Figure 15: Number of IP SLAs Operations Is Greater Than the Schedule Period--Uneven Distribution



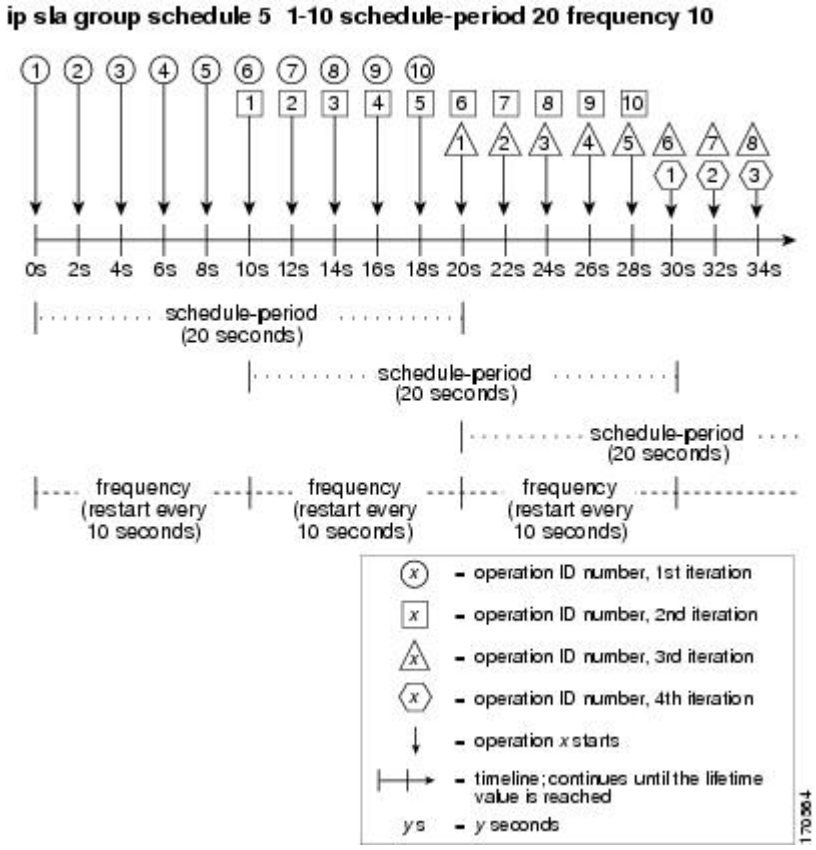
In this example, the IP SLAs multiple operations scheduling functionality calculates how many operations it should start in each 1-second interval by dividing the number of operations by the schedule period (10 operations divided by 4 seconds, which equals 2.5 operations every 1 second). Since the number of operations does not equally divide into 1-second intervals, this number will be rounded off to the next whole number (see the figure above) with the remaining operations to start at the last 1-second interval.

IP SLAs Multiple Operations Scheduling with Scheduling Period Greater Than Frequency

The value of frequency is the amount of time that passes before the schedule group is restarted. If the schedule period is greater than the frequency, there will be a period of time in which the operations in one iteration of an operation group overlap with the operations of the following iteration.

The figure below illustrates the scheduling of operation 1 to operation 10 within operation group 5. Operation group 5 has a schedule period of 20 seconds and a frequency of 10 seconds.

Figure 16: IP SLAs Group Scheduling with Schedule Period Greater Than Frequency



In this example, the first operation (operation 1) in operation group 5 will start at 0 seconds. All 10 operations in operation group 5 (operation 1 to operation 10) must be started in the schedule period of 20 seconds. The start time of each IP SLAs operation is evenly distributed over the schedule period by dividing the schedule period by the number of operations (20 seconds divided by 10 operations). Therefore, each operation will start 2 seconds after the previous operation.

In the first iteration of operation group 5, operation 1 starts at 0 seconds, and operation 10, the last operation in the operation group, starts at 18 seconds. Because the operation group is configured to restart every 10 seconds (**frequency 10**), the second iteration of operation group 5 starts again at 10 seconds, before the first iteration is completed. Therefore, an overlap of operations 6 to 10 of the first iteration occurs with operations 1 to 5 of the second iteration during the time period of 10 to 18 seconds (see the figure above). Similarly, there is an overlap of operations 6 to 10 of the second iteration with operations 1 to 5 of the third iteration during the time period of 20 to 28 seconds.

In this example, the start time of operation 1 and operation 6 need not be at exactly the same time, but will be within the same 2-second interval.

The configuration described in this section is not recommended as you can configure multiple operations to start within the same 1-second interval by configuring the number of operations greater than the schedule

period. For information, see the "Multiple Operations Scheduling When the Number of IP SLAs Operations Are Greater Than the Schedule Period" section.

IP SLAs Random Scheduler

The IP SLAs Random Scheduler feature is an enhancement to the existing IP SLAs Multioperation Scheduling feature. The IP SLAs Multioperation Scheduling feature provides the capability to easily schedule multiple IP SLAs operations to begin at intervals equally distributed over a specified duration of time and to restart at a specified frequency. With the IP SLAs Random Scheduler feature, you can now schedule multiple IP SLAs operations to begin at random intervals uniformly distributed over a specified duration of time and to restart at uniformly distributed random frequencies within a specified frequency range. Random scheduling improves the statistical metrics for assessing network performance.

Note The IP SLAs Random Scheduler feature is not in compliance with RFC2330 because it does not account for inter-packet randomness.

The IP SLAs random scheduler option is disabled by default. To enable the random scheduler option, you must set a frequency range when configuring a group schedule in global configuration mode. The group of operations restarts at uniformly distributed random frequencies within the specified frequency range. The following guidelines apply for setting the frequency range:

- The starting value of the frequency range should be greater than the timeout values of all the operations in the group operation.
- The starting value of the frequency range should be greater than the schedule period (amount of time for which the group operation is scheduled). This guideline ensures that the same operation does not get scheduled more than once within the schedule period.

The following guidelines apply if the random scheduler option is enabled:

- The individual operations in a group operation will be uniformly distributed to begin at random intervals over the schedule period.
- The group of operations restarts at uniformly distributed random frequencies within the specified frequency range.
- The minimum time interval between the start of each operation in a group operation is 100 milliseconds (0.1 seconds). If the random scheduler option is disabled, the minimum time interval is 1 second.
- Only one operation can be scheduled to begin at any given time. If the random scheduler option is disabled, multiple operations can begin at the same time.
- The first operation will always begin at 0 milliseconds of the schedule period.
- The order in which each operation in a group operation begins is random.

How to Configure an IP SLAs Multioperation Scheduler

Scheduling Multiple IP SLAs Operations

Note

- All IP SLAs operations to be scheduled must be already configured.
- The frequency of all operations scheduled in a multioperation group should be the same.
- List of one or more operation ID numbers to be added to a multioperation group is limited to a maximum of 125 characters, including commas (,).

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **ip sla group schedule** *group-operation-number operation-id-numbers* **schedule-period** *schedule-period-range* [**ageout** *seconds*] [**frequency** *group-operation-frequency*] [**life**{**forever** | *seconds*}] [**start-time**{*hh:mm*[*:ss*] [*month day* | *day month*] | **pending** | **now** | **after** *hh:mm:ss*}]
4. **exit**
5. **show ip sla group schedule**
6. **show ip sla configuration**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Device> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Device# configure terminal`	Enters global configuration mode.
Step 3	**ip sla group schedule** *group-operation-number operation-id-numbers* **schedule-period** *schedule-period-range* [**ageout** *seconds*] [**frequency** *group-operation-frequency*] [**life**{**forever**	*seconds*}] [**start-time**{*hh:mm*[*:ss*] [*month day*	*day month*]	**pending**	**now**	**after** *hh:mm:ss*}]	Specifies an IP SLAs operation group number and the range of operation numbers to be scheduled in global configuration mode.

	Command or Action	Purpose
	Example: `Device(config)# ip sla group schedule 1 3,4,6-9 schedule-period 50 frequency range 80-100`	
Step 4	**exit** **Example:** `Device(config)# exit`	Returns to the privileged EXEC mode.
Step 5	**show ip sla group schedule** **Example:** `Device# show ip sla group schedule`	(Optional) Displays the IP SLAs group schedule details.
Step 6	**show ip sla configuration** **Example:** `Device# show ip sla configuration`	(Optional) Displays the IP SLAs configuration details.

Enabling the IP SLAs Random Scheduler

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **ip sla group schedule** *group-operation-number operation-id-numbers* **schedule-period** *seconds* [**ageout** *seconds*] [**frequency** [*seconds*| **range** *random-frequency-range*]] [**life**{**forever** | *seconds*}] [**start-time**{*hh:mm*[*:ss*] [*month day* | *day month*] | **pending** | **now** | **after** *hh:mm:ss*}]
4. **exit**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Device> enable`	Enables privileged EXEC mode. • Enter your password if prompted.

	Command or Action	Purpose
Step 2	**configure terminal** **Example:** `Device# configure terminal`	Enters global configuration mode.
Step 3	**ip sla group schedule** *group-operation-number operation-id-numbers* **schedule-period** *seconds* [**ageout** *seconds*] [**frequency** [*seconds*| **range** *random-frequency-range*]] [**life**{**forever** | *seconds*}] [**start-time**{*hh:mm*[*:ss*] [*month day* | *day month*] | **pending** | **now** | **after** *hh:mm:ss*}] **Example:** `Device(config)# ip sla group schedule 2 1-3 schedule-period 50 frequency range 80-100`	Specifies the scheduling parameters of a group of IP SLAs operations. • To enable the IP SLAs random scheduler option, you must configure the **frequency range** *random-frequency-range* keywords and argument.
Step 4	**exit** **Example:** `Device(config)# exit`	Exits global configuration mode and returns to privileged EXEC mode.

Verifying IP SLAs Multiple Operations Scheduling

SUMMARY STEPS

1. **show ip sla statistics**
2. **show ip sla group schedule**
3. **show ip sla configuration**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**show ip sla statistics** **Example:** `Device# show ip sla statistics`	(Optional) Displays the IP SLAs operation details.

	Command or Action	Purpose
Step 2	**show ip sla group schedule** **Example:** `Device# show ip sla group schedule`	(Optional) Displays the IP SLAs group schedule details.
Step 3	**show ip sla configuration** **Example:** `Device# show ip sla configuration`	(Optional) Displays the IP SLAs configuration details.

Examples

After you have scheduled the multiple IP SLAs operations, you can verify the latest operation details using the appropriate **show** commands.

The following example schedules IP SLAs operations 1 through 20 in the operation group 1 with a schedule period of 60 seconds and a life value of 1200 seconds. By default, the frequency is equivalent to the schedule period. In this example, the start interval is 3 seconds (schedule period divided by number of operations).

```
Device# ip sla group schedule 1 1-20 schedule-period 60 life 1200
```

The following example shows the details of the scheduled multiple IP SLAs operation using the **show ip sla group schedule** command.

```
Device# show ip sla group schedule
Group Entry Number: 1
Probes to be scheduled: 1-20
Total number of probes: 20
Schedule period: 60
Group operation frequency: Equals schedule period
Status of entry (SNMP RowStatus): Active
Next Scheduled Start Time: Start Time already passed
Life (seconds): 1200
Entry Ageout (seconds): never
```

The following example shows the details of the scheduled multiple IP SLAs operation using the **show ip sla configuration** command. The last line in the example indicates that the IP SLAs operations are multiple scheduled (TRUE).

```
Device# show ip sla configuration 1
Entry number: 1
Owner:
Tag:
Type of operation to perform: udpEcho
Target address: 10.2.31.121
Source address: 0.0.0.0
Target port: 9001
Source port: 0
Request size (ARR data portion): 16
Operation timeout (milliseconds): 5000
Type Of Service parameters: 0x0
Verify data: No
Data pattern:
Vrf Name:
Control Packets: enabled
```

```
Operation frequency (seconds): 60
Next Scheduled Start Time: Start Time already passed
Life (seconds): 1200
Entry Ageout (seconds): never
Recurring (Starting Everyday): FALSE
Status of entry (SNMP RowStatus): Active
Threshold (milliseconds): 5000
Number of statistic hours kept: 2
Number of statistic distribution buckets kept: 1
Statistic distribution interval (milliseconds): 20
Enhanced History:
Number of history Lives kept: 0
Number of history Buckets kept: 15
History Filter Type: None
Group Scheduled : TRUE
```

The following example shows the latest operation start time of the scheduled multiple IP SLAs operation, when the operations are scheduled at equal intervals, using the **show ip sla statistics** command:

```
Device# show ip sla statistics | include Latest operation start time
Latest operation start time: *03:06:21.760 UTC Tue Oct 21 2003
Latest operation start time: *03:06:24.754 UTC Tue Oct 21 2003
Latest operation start time: *03:06:27.751 UTC Tue Oct 21 2003
Latest operation start time: *03:06:30.752 UTC Tue Oct 21 2003
Latest operation start time: *03:06:33.754 UTC Tue Oct 21 2003
Latest operation start time: *03:06:36.755 UTC Tue Oct 21 2003
Latest operation start time: *03:06:39.752 UTC Tue Oct 21 2003
Latest operation start time: *03:06:42.753 UTC Tue Oct 21 2003
Latest operation start time: *03:06:45.755 UTC Tue Oct 21 2003
Latest operation start time: *03:06:48.752 UTC Tue Oct 21 2003
Latest operation start time: *03:06:51.753 UTC Tue Oct 21 2003
Latest operation start time: *03:06:54.755 UTC Tue Oct 21 2003
Latest operation start time: *03:06:57.752 UTC Tue Oct 21 2003
Latest operation start time: *03:07:00.753 UTC Tue Oct 21 2003
Latest operation start time: *03:07:03.754 UTC Tue Oct 21 2003
Latest operation start time: *03:07:06.752 UTC Tue Oct 21 2003
Latest operation start time: *03:07:09.752 UTC Tue Oct 21 2003
Latest operation start time: *03:07:12.753 UTC Tue Oct 21 2003
Latest operation start time: *03:07:15.755 UTC Tue Oct 21 2003
Latest operation start time: *03:07:18.752 UTC Tue Oct 21 2003
```

Configuration Examples for an IP SLAs Multioperation Scheduler

Example Scheduling Multiple IP SLAs Operations

The following example shows how to scheduls IP SLAs operations 1 to 10 in the operation group 1 with a schedule period of 20 seconds. By default, the frequency is equivalent to the schedule period.

```
Device# ip sla group schedule 1 1-10 schedule-period 20
```

The following example shows the details of the scheduled multiple IP SLAs operation using the **show ip sla group schedule** command. The last line in the example indicates that the IP SLAs operations are multiple scheduled (TRUE).

```
Device# show ip sla group schedule
Multi-Scheduling Configuration:
Group Entry Number: 1
Probes to be scheduled: 1-10
Schedule period :20
Group operation frequency: 20
Multi-scheduled: TRUE
```

Example Enabling the IP SLAs Random Scheduler

The following example shows how to schedule IP SLAs operations 1 to 3 as a group (identified as group 2). In this example, the operations are scheduled to begin at uniformly distributed random intervals over a schedule period of 50 seconds. The first operation is scheduled to start immediately. The interval is chosen from the specified range upon every invocation of the probe. The random scheduler option is enabled and the uniformly distributed random frequencies at which the group of operations will restart is chosen within the range of 80-100 seconds.

```
ip sla group schedule 2 1-3 schedule-period 50 frequency range 80-100 start-time now
```

Additional References

Related Documents

Related Topic	Document Title
Cisco IOS commands	Cisco IOS Master Commands List, All Releases
Cisco IOS IP SLAs commands	Cisco IOS IP SLAs Command Reference, All Releases
Cisco IOS IP SLAs: general information	"Cisco IOS IP SLAs Overview" module of the *Cisco IOS IP SLAs Configuration Guide*.
Multioperation scheduling for IP SLAs	"Configuring Multioperation Scheduling of IP SLAs Operations" module of the *Cisco IOS P SLAs Configuration Guide*
Proactive threshold monitoring for IP SLAs	"Configuring Proactive Threshold Monitoring of IP SLAs Operations" module of the *Cisco IOS IP SLAs Configuration Guide*

MIBs

MIBs	MIBs Link
CISCO-RTTMON-MIB	To locate and download MIBs for selected platforms, Cisco IOS releases, and feature sets, use Cisco MIB Locator found at the following URL: http://www.cisco.com/go/mibs

Technical Assistance

Description	Link
The Cisco Support and Documentation website provides online resources to download documentation, software, and tools. Use these resources to install and configure the software and to troubleshoot and resolve technical issues with Cisco products and technologies. Access to most tools on the Cisco Support and Documentation website requires a Cisco.com user ID and password.	http://www.cisco.com/cisco/web/support/index.html

Feature Information for a IP SLAs Multioperation Scheduler

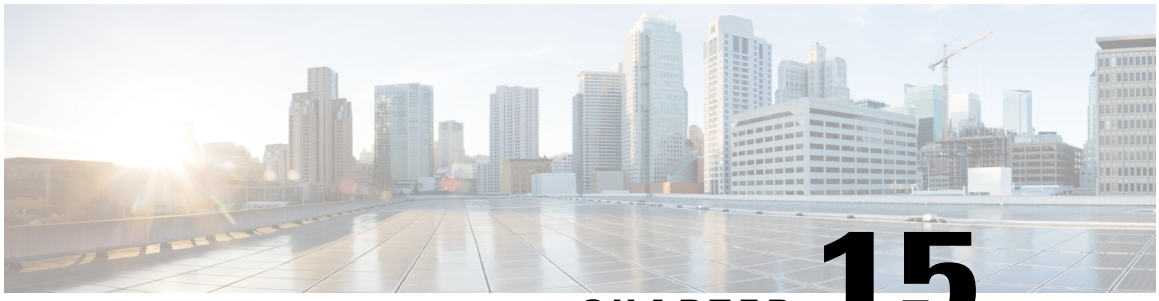
The following table provides release information about the feature or features described in this module. This table lists only the software release that introduced support for a given feature in a given software release train. Unless noted otherwise, subsequent releases of that software release train also support that feature.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to . An account on Cisco.com is not required.

Table 21: Feature Information for IP SLAs Multioperation Scheduling

Feature Name	Releases	Feature Information
IP SLAs Multioperation Scheduler	Cisco IOS XE Release 3.2SE	The IP SLAs Multioperation Scheduler feature provides a highly scalable infrastructure for IP SLAs by allowing you to schedule multiple IP SLAs operations using a single command. In Cisco IOS XE Release 3.2SE, this feature was supported on the following platforms: • Catalyst 3650 Series Switches • Catalyst 3850 Series Switches • Cisco 5760 Wireless LAN Controller

Feature Name	Releases	Feature Information
IP SLAs Random Scheduler	Cisco IOS XE Release 3.2SE	The IP SLAs Random Scheduler feature provides the capability to schedule multiple IP SLAs operations to begin at random intervals uniformly distributed over a specified duration of time and to restart at uniformly distributed random frequencies within a specified frequency range. In Cisco IOS XE Release 3.2SE, this feature was supported on the following platforms: • Catalyst 3650 Series Switches • Catalyst 3850 Series Switches • Cisco 5760 Wireless LAN Controller



CHAPTER 15

Configuring Proactive Threshold Monitoring for IP SLAs Operations

This document describes the proactive monitoring capabilities of IP Service Level Agreements (SLAs) using thresholds and reaction triggering.

Finding Feature Information

Your software release may not support all the features documented in this module. For the latest caveats and feature information, see Bug Search Tool and the release notes for your platform and software release. To find information about the features documented in this module, and to see a list of the releases in which each feature is supported, see the feature information table.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to www.cisco.com/go/cfn. An account on Cisco.com is not required.

Information About Proactive Threshold Monitoring

IP SLAs Reaction Configuration

IP SLAs reactions are configured to trigger when a monitored value exceeds or falls below a specified level or when a monitored event, such as a timeout or connection loss, occurs. If IP SLAs measures too high or too

low of any configured reaction, IP SLAs can generate a notification to a network management application or trigger another IP SLA operation to gather more data.

When an IP SLA operation is triggered, the (triggered) target operation starts and continues to run independently and without knowledge of the condition of the triggering operation. The target operation continues to run until its life expires, as specified by the target operation's configured lifetime value. The target operation must finish its life before it can be triggered again.

In Cisco IOS Release 15.2(3) and later releases, the (triggered) target operation runs until the condition-cleared event. After which the target operation gracefully stops and the state of the target operation changes from Active to Pending so it can be triggered again.

Supported Reactions by IP SLAs Operation

The tables below list which reactions are supported for each IP SLA operation.

Table 22: Supported Reaction Configuration, by IP SLA Operation

Reaction	ICMP Echo	Path Echo	UDP Jitter	UDP Echo	TCP Connect	DHCP	DLSW	ICMP Jitter	DNS	Frame Relay
Failure	Y	--	Y	Y	Y	Y	--	Y	Y	--
RTT	Y	Y	--	Y	Y	Y	Y	--	Y	Y
RTTAvg	--	--	Y	--	--	--	--	Y	--	--
timeout	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
connectionLoss	--	--	Y	Y	Y	--	--	--	--	
verifyError	--	--	Y	Y	--	--	--	Y	--	Y
jitterSDAvg	--	--	Y	--	--	--		Y	--	--
jitterAvg	--	--	Y	--	--	--	--	Y	--	--
packetLateArrival	--	--	Y	--	--	--	--	Y	--	--
packetOutOfSequence	--	--	Y	--	--	--	--	Y	--	--
MaxOfPositivesSD	--	--	Y	--	--	--		Y	--	--
MaxOfNegativesSD	--	--	Y	--	--	--	--	Y	--	--
MaxOfPositivesDS	--	--	Y	--	--	--	--	Y	--	--
MaxOfNegativesDS	--	--	Y	--	--	--	--	Y	--	--
MOS	--	--	Y	--	--	--		--	--	--

Reaction	ICMP Echo	Path Echo	UDP Jitter	UDP Echo	TCP Connect	DHCP	DLSW	ICMP Jitter	DNS	Frame Relay
ICPIF	--	--	Y	--	--	--	--	--	--	--
PacketLossDS	--	--	Y	--	--	--	--	--	--	--
PacketLossSD	--	--	Y	--	--	--	--	--	--	--
PacketMIA	--	--	Y	--	--	--		--	--	--
iaJitterDS	--	--	--	--	--	--	--	--	--	--
frameLossDS	--	--	--	--	--	--	--	--	--	--
mosLQDSS	--	--	--	--	--	--	--	--	--	--
mosCQDS	--	--	--	--	--	--	--	--	--	--
rfactorDS	--	--	--	--	--	--	--	--	--	--
iaJitterSD	--	--	--	--	--	--	--	--	--	--
successivePackLoss	--	--	--	--	--	--	--	Y	--	--
MaxOfLatencyDS	--	--	--	--	--	--	--	Y	--	--
MaxOfLatencySD	--	--	--	--	--	--	--	Y	--	--
LatencyDS	--	--	--	--	--	--	--	Y	--	--
LatencySD	--	--	--	--	--	--	--	Y	--	--
packetLoss	--	--	--	--	--	--	--	Y	--	--

Table 23: Supported Reaction Configuration, by IP SLA Operation

Reaction	HTTP	SLM	RTP	FTP	Lsp Trace	Post delay	Path Jitter	LSP Ping	Gatekeeper Registration
Failure	--	--	--	--	--	--	--	--	--
RTT	Y	Y	Y	Y	Y	Y	Y	Y	Y
RTTAvg	--	--	--	--	--	--	--	--	--
timeout	Y	Y	Y	Y	--	Y	Y	Y	Y
connectionLoss	Y		Y	Y	Y	--	--	Y	--

Reaction	HTTP	SLM	RTP	FTP	Lsp Trace	Post delay	Path Jitter	LSP Ping	Gatekeeper Registration
verifyError	--	--	--	--	--	--	--	--	--
jitterSDAvg	--	--	--	--	--	--	Y	--	--
jitterAvg	--	--	--	--	--	--	Y	--	--
packetLateArrival	--	--	--	--	--	--	Y	--	--
packetOutOfSequence	--	--	--	--	--	--	Y	--	--
MaxOfPositivesSD	--	--	--	--	--	--	Y	--	--
MaxOfNegativesSD	--	--	--	--	--	--	Y	--	--
MaxOfPositivesDS	--	--	--	--	--	--	Y	--	--
MaxOfNegativesDS	--	--	--	--	--	--	Y	--	--
MOS	--	--	--	--	--	--	--	--	--
ICPIF	--	--	--	--	--	--	--	--	--
PacketLossDS	--	--	Y	--	--	--	--	--	--
PacketLossSD	--	--	Y	--	--	--	--	--	--
PacketMIA	--	--	Y	--	--	--	--	--	--
iaJitterDS	--	--	Y	--	--	--	--	--	--
frameLossDS	--	--	Y	--	--	--	--	--	--
mosLQDSS	--	--	Y	--	--	--	--	--	--
mosCQDS	--	--	Y	--	--	--	--	--	--
rfactorDS	--	--	Y						
iaJitterSD	--	--	Y	--	--	--	--	--	--
successivePacketLoss	--	--	--	--	--	--	--	--	--
MaxOfLatencyDS	--	--	--	--	--	--	--	--	--
MaxOfLatencySD	--	--	--	--	--	--	--	--	--
LatencyDS	--	--	--	--	--	--	--	--	--

Reaction	HTTP	SLM	RTP	FTP	Lsp Trace	Post delay	Path Jitter	LSP Ping	Gatekeeper Registration
LatencySD	--	--	--	--	--	--	--	--	--
packetLoss	--	--	--	--	--	--	--	--	--

IP SLAs Threshold Monitoring and Notifications

IP SLAs supports proactive threshold monitoring and notifications for performance parameters such as average jitter, unidirectional latency, bidirectional round-trip time (RTT), and connectivity for most IP SLAs operations. The proactive monitoring capability also provides options for configuring reaction thresholds for important VoIP related parameters including unidirectional jitter, unidirectional packet loss, and unidirectional VoIP voice quality scoring.

Notifications for IP SLAs are configured as a triggered reaction. Packet loss, jitter, and Mean Operation Score (MOS) statistics are specific to IP SLAs jitter operations. Notifications can be generated for violations in either direction (source-to-destination and destination-to-source) or for out-of-range RTT values for packet loss and jitter. Events, such as traps, are triggered when the RTT value rises above or falls below a specified threshold.

IP SLAs can generate system logging (syslog) messages when a reaction condition occurs. System logging messages can be sent as Simple Network Management Protocol (SNMP) traps (notifications) using the CISCO-RTTMON-MIB. SNMP traps for IP SLAs are supported by the CISCO-RTTMON-MIB and CISCO-SYSLOG-MIB.

Severity levels in the CISCO-SYSLOG-MIB are defined as follows: SyslogSeverity INTEGER {emergency(1), alert(2), critical(3), error(4), warning(5), notice(6), info(7), debug(8)}

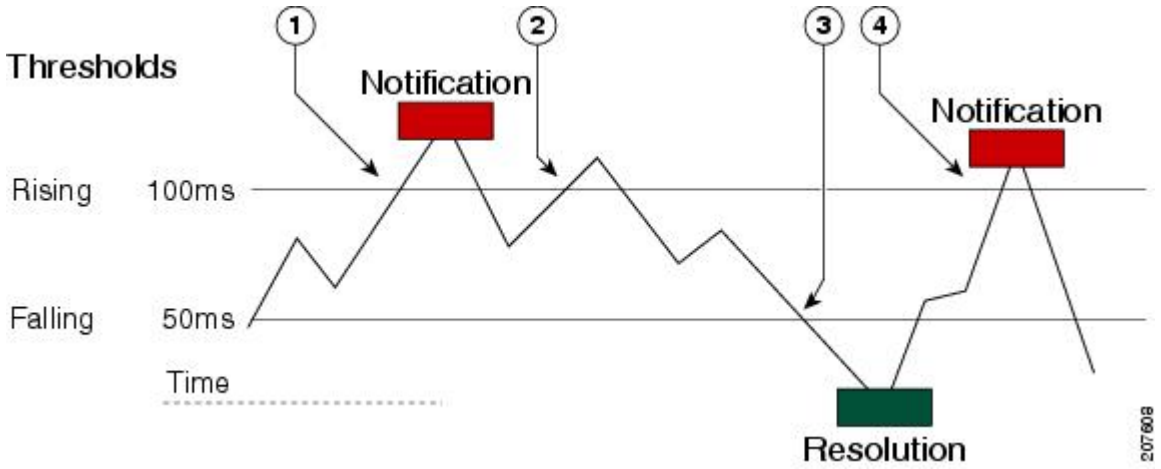
The values for severity levels are defined differently for the system logging process in software. Severity levels for the system logging process in Cisco software are defined as follows: {emergency (0), alert (1), critical (2), error (3), warning (4), notice (5), informational (6), debugging (7)}.

IP SLAs Threshold violations are logged as level 6 (informational) within the Cisco system logging process but are sent as level 7 (info) traps from the CISCO-SYSLOG-MIB.

Notifications are not issued for every occurrence of a threshold violation. The figure below illustrates the sequence for a triggered reaction that occurs when the monitored element exceeds the upper threshold. An event is sent and a notification is issued when the rising threshold is exceeded for the first time. Subsequent

threshold-exceeded notifications are issued only after the monitored value falls below the falling threshold before exceeding the rising threshold ag ain .

Figure 17: IP SLAs Triggered Reaction Condition and Notifications for Threshold Exceeded



1	An event is sent and a threshold-exceeded notification is issued when the rising threshold is exceeded for the first time.
2	Consecutive over-rising threshold violations occur without issuing additional notifications.
3	The monitored value goes below the falling threshold.
4	Another threshold-exceeded notification is issued when the rising threshold is exceeded only after the monitored value first fell below the falling threshold.

Note A lower-threshold notification is also issued the first time that the monitored element falls below the falling threshold (3). As described, subsequent notifications for lower-threshold violations will be issued only after the rising threshold is exceeded before the monitored value falls below the falling threshold again.

RTT Reactions for Jitter Operations

RTT reactions for jitter operations are triggered only at the end of the operation and use the latest value for the return-trip time (LatestRTT), which matches the value of the average return-trip time (RTTAvg).

SNMP traps for RTT for jitter operations are based on the value of the average return-trip time (RTTAvg) for the whole operation and do not include RTT values for each individual packet sent during the operation.

For example, if the average is below the threshold, up to half of the packets can actually be above threshold but this detail is not included in the notification because the value is for the whole operation only.

Only syslog messages are supported for RTTAvg threshold violations. Syslog nmessages are sent from the CISCO-RTTMON-MIB.

How to Configure Proactive Threshold Monitoring

Configuring Proactive Threshold Monitoring

Perform this task to configure thresholds and reactive triggering for generating traps or starting another operation.

Before You Begin

- IP SLAs operations to be started when violation conditions are met must be configured.

Note

- RTT reactions for jitter operations are triggered only at the end of the operation and use the latest value for the return-trip time (LatestRTT).
- SNMP traps for RTT for jitter operations are based on the average value for the return-trip time (RTTAvg) for the whole operation only and do not include return-trip time values for individual packets sent during the operation. Only syslog messages are supported for RTTAvg threshold violations.
- Only syslog messages are supported for RTT violations during Jitter operations.
- Only SNMP traps are supported for RTT violations during non-Jitter operations.
- Only syslog messages are supported for non-RTT violations other than timeout, connectionLoss, or verifyError.
- Both SNMP traps and syslog messages are supported for timeout, connectionLoss, or verifyError violations only.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **ip sla reaction-configuration** *operation-number* **react** *monitored-element* [**action-type** *option*] [**threshold-type** {**average** [*number-of-measurements*] | **consecutive** [*occurrences*] | **immediate** | **never** | **xofy** [*x-value y-value*]}] [**threshold-value** *upper-threshold lower-threshold*]
4. **ip sla reaction-trigger** *operation-number target-operation*
5. **ip sla logging traps**
6. Do one of the following:
   - **snmp-server enable traps rtr**
   - **snmp-server enable traps syslog**
7. **snmp-server host** {*hostname* | *ip-address*} [**vrf** *vrf-name*] [**traps** | **informs**] [**version** {**1** | **2c** | **3** [**auth** | **noauth** | **priv**]}] *community-string* [**udp-port** *port*] [*notification-type*]
8. **exit**
9. **show ip sla reaction- configuration** [*operation-number*]
10. **show ip sla reaction- trigger** [*operation-number*]

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Device> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Device# configure terminal`	Enters global configuration mode.
Step 3	**ip sla reaction-configuration** *operation-number* **react** *monitored-element* [**action-type** *option*] [**threshold-type** {**average** [*number-of-measurements*]	**consecutive** [*occurrences*]	**immediate**	**never**	**xofy** [*x-value y-value*]}] [**threshold-value** *upper-threshold lower-threshold*] **Example:** `Device(config)# ip sla reaction-configuration 10 react jitterAvg threshold-type immediate threshold-value 5000 3000 action-type trapAndTrigger`	Configures the action (SNMP trap or IP SLAs trigger) that is to occur based on violations of specified thresholds.

	Command or Action	Purpose
Step 4	**ip sla reaction-trigger** *operation-number target-operation* **Example:** `Device(config)# ip sla reaction-trigger 10 2`	(Optional) Starts another IP SLAs operation when the violation conditions are met. • Required only if the **ip sla reaction-configuration** command is configured with either the **trapAndTrigger**or **triggerOnly**keyword.
Step 5	**ip sla logging traps** **Example:** `Device(config)# ip sla logging traps`	(Optional) Enables IP SLAs syslog messages from CISCO-RTTMON-MIB.

Step 6	Do one of the following:
	• **snmp-server enable traps rtr**
	• **snmp-server enable traps syslog**
	Example:
	`Device(config)# snmp-server enable traps rtr`
	Example:
	`Device(config)# snmp-server enable traps syslog`
		• (Optional) The first example shows how to enable the system to generate CISCO-RTTMON-MIB traps.
		• (Optional) The second example shows how to enable the system to generate CISCO-SYSLOG-MIB traps.

Step 7	**snmp-server host** {*hostname* | *ip-address*} [**vrf** *vrf-name*] [**traps** | **informs**] [**version** {**1** | **2c** | **3** [**auth** | **noauth** | **priv**]}] *community-string* [**udp-port** *port*] [*notification-type*] **Example:** `Device(config)# snmp-server host 10.1.1.1 public syslog`	(Optional) Sends traps to a remote host. • Required if the **snmp-server enable traps** command is configured.
Step 8	**exit** **Example:** `Device(config)# exit`	Exits global configuration mode and returns to privileged EXEC mode.
Step 9	**show ip sla reaction- configuration** [*operation-number*] **Example:** `Device# show ip sla reaction-configuration 10`	(Optional) Displays the configuration of proactive threshold monitoring.

	Command or Action	Purpose
Step 10	**show ip sla reaction- trigger** [*operation-number*] **Example:** `Device# show ip sla reaction-trigger 2`	(Optional) Displays the configuration status and operational state of target operations to be triggered.

Configuration Examples for Proactive Threshold Monitoring

Example Configuring an IP SLAs Reaction Configuration

In the following example, IP SLAs operation 10 is configured to send an SNMP logging trap when the MOS value either exceeds 4.9 (best quality) or falls below 2.5 (poor quality):

```
Device(config)# ip sla reaction-configuration 10 react mos threshold-type immediate
threshold-value 490 250 action-type trapOnly
```

The following example shows the default configuration for the **ip sla reaction-configuration** command:

```
Device# show ip sla reaction-configuration 1
Entry number: 1
Reaction Configuration not configured
Device# configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
Device(config)# ip sla reaction-configuration 1
Device(config)# do show ip sla reaction-configuration 1
Entry number: 1
Reaction: rtt
Threshold Type: Never
Rising (milliseconds): 5000
Falling (milliseconds): 3000
Threshold Count: 5
Threshold Count2: 5
Action Type: None
```

Example Verifying an IP SLAs Reaction Configuration

The following example shows that multiple monitored elements are configured for the IP SLAs operation (1), as indicated by the values of Reaction: in the output:

```
Device# show ip sla reaction-configuration

Entry Number: 1
Reaction: RTT
Threshold type: Never
Rising (milliseconds): 5000
Falling (milliseconds): 3000
Threshold Count: 5
Threshold Count2: 5
Action Type: None
Reaction: jitterDSAvg
Threshold type: average
```

```
Rising (milliseconds): 5
Falling (milliseconds): 3
Threshold Count: 5
Threshold Count2: 5
Action Type: triggerOnly
Reaction: jitterDSAvg
Threshold type:  immediate
Rising (milliseconds): 5
Falling (milliseconds): 3
Threshold Count: 5
Threshold Count2: 5
Action Type: trapOnly
Reaction: PacketLossSD
Threshold type:  immediate
Rising (milliseconds): 5
Threshold Falling (milliseconds): 3
Threshold Count: 5
Threshold Count2: 5
Action Type: trapOnly
```

Example Triggering SNMP Notifications

The following example shows how to configure proactive threshold monitoring so that CISCO-SYSLOG-MIB traps are sent to the remote host at 10.1.1.1 if the threshold values for RTT or VoIP MOS are violated:

```
! Configure the operation on source.
Device(config)# ip sla 1

Device(config-ip-sla)# udp-jitter 10.1.1.1 3000 codec g711alaw
Device(config-ip-sla-jitter)# exit

Device(config)# ip sla schedule 1 start now life forever

! Configure thresholds and reactions.
Device(config)# ip sla reaction-configuration 1 react rtt threshold-type immediate
threshold-value 3000 2000 action-type trapOnly

Device(config)# ip sla reaction-configuration 1 react MOS threshold-type consecutive 4
threshold-value 390 220 action-type trapOnly

Device(config)# ip sla logging traps

! The following command sends traps to the specified remote host.
Device(config)# snmp-server host 10.1.1.1 version 2c public syslog

! The following command is needed for the system to generate CISCO-SYSLOG-MIB traps.
Device(config)# snmp-server enable traps syslog
```

The following sample system logging messages shows that IP SLAs threshold violation notifications are generated as level 6 (informational) in the Cisco system logging process:

```
3d18h:%RTT-6-SAATHRESHOLD:RTR(11):Threshold exceeded for MOS
```

This following sample SNMP notification from the CISCO-SYSLOG-MIB for the same violation is a level 7 (info) notification:

```
3d18h:SNMP:V2 Trap, reqid 2, errstat 0, erridx 0
 sysUpTime.0 = 32613038
 snmpTrapOID.0 = ciscoSyslogMIB.2.0.1
 clogHistoryEntry.2.71 = RTT
 clogHistoryEntry.3.71 = 7
 clogHistoryEntry.4.71 = SAATHRESHOLD
```

```
clogHistoryEntry.5.71 = RTR(11):Threshold exceeded for MOS
clogHistoryEntry.6.71 = 32613037
```

Additional References

Related Documents

Related Topic	Document Title
Cisco IOS commands	Cisco IOS Master Commands List, All Releases
Cisco IOS IP SLAs commands	Cisco IOS IP SLAs Command Reference

MIBs

MIBs	MIBs Link
• CISCO-RTTMON-MIB • CISCO-SYSLOG-MIB	To locate and download MIBs for selected platforms, Cisco IOS releases, and feature sets, use Cisco MIB Locator found at the following URL: http://www.cisco.com/go/mibs

Technical Assistance

Description	Link
The Cisco Support and Documentation website provides online resources to download documentation, software, and tools. Use these resources to install and configure the software and to troubleshoot and resolve technical issues with Cisco products and technologies. Access to most tools on the Cisco Support and Documentation website requires a Cisco.com user ID and password.	http://www.cisco.com/cisco/web/support/index.html

Feature Information for IP SLAs Proactive Threshold Monitoring

The following table provides release information about the feature or features described in this module. This table lists only the software release that introduced support for a given feature in a given software release train. Unless noted otherwise, subsequent releases of that software release train also support that feature.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to . An account on Cisco.com is not required.

Table 24: Feature Information for IP SLAs Proactive Threshold Monitoring

Feature Name	Releases	Feature Information
IP SLAs - Reaction Threshold	Cisco IOS XE Release 3.2SE	Cisco IOS IP SLAs proactive threshold monitoring capability allows you to configure an IP SLAs operation to react to certain measured network conditions. In Cisco IOS XE Release 3.2SE, this feature was supported on the following platforms: • Catalyst 3650 Series Switches • Catalyst 3850 Series Switches • Cisco 5760 Wireless LAN Controller
IP SLAs - VoIP Traps	Cisco IOS XE Release 3.2SE	The IP SLA - VoIP Traps feature includes new capabilities for configuring reaction thresholds for important VoIP related parameters such as unidirectional jitter, unidirectional packet loss, and unidirectional VoIP voice quality scoring (MOS scores). In Cisco IOS XE Release 3.2SE, this feature was supported on the following platforms: • Catalyst 3650 Series Switches • Catalyst 3850 Series Switches • Cisco 5760 Wireless LAN Controller

Feature Name	Releases	Feature Information
IP SLAs Additional Threshold Traps	Cisco IOS XE Release 3.2SE	This enhancement for IP SLAs reaction threshold monitoring includes per direction average jitter, per direction packet loss, maximum positive and negative jitter, and Mean Opinion Score (MOS) traps. The feature also enables one-way latency jitter, packet loss and latency traps within IP SLAs and includes traps for packet loss due to missing in action and late arrivals. In Cisco IOS XE Release 3.2SE, this feature was supported on the following platforms: • Catalyst 3650 Series Switches • Catalyst 3850 Series Switches • Cisco 5760 Wireless LAN Controller